PALAEONTOLOGICAL HERITAGE REPORT: COMBINED DESKTOP & FIELD-BASED ASSESSMENT

PROPOSED SPRINGBOK SOLAR POWER PLANT ON THE FARM WELTEVREDE NO. 638 NEAR VIRGINIA, MATJHABENG LOCAL MUNICIPALITY, FREE STATE PROVINCE

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EXECUTIVE SUMMARY

Springbok Solar Power Plant (RF) (Pty) Ltd is proposing to develop a photovoltaic solar facility and associated infrastructure, including a battery storage facility on Farm Weltevrede No. 638, situated *c*. 10 km SW of Virginia, Matjhabeng Local Municipality, Free State Province. The solar facility will have an installed capacity of up to 150 MW and a total footprint of approximately 280 hectares. Connection to the National Grid will probably be *via* a *c*. 5 km long 132 kV powerline to the existing Theseus MTS 400/132/22kV Substation for which a 100m-wide corridor (2 route options) is assessed here.

The solar facility and grid connection project areas are underlain near-surface or at depth by continental sediments of the Adelaide Subgroup (Lower Beaufort Group, Karoo Supergroup) of Late Permian to Early Triassic age that are generally associated with fossil biotas of the *Daptocephalus* Assemblage Zone. A palaeontological site visit indicated that exposure levels of Permian bedrocks within the project area (*i.e.* solar facility *plus* associated grid connection corridor) are generally very low due to low topographic relief, widespread sandy soil cover and dense grassy vegetation. The only fossils recorded here comprise locally common, small blocks of petrified wood within downwasted surface gravels and gully-eroded aeolianites (wind-blown sands). These fossil wood blocks have been reworked from the underlying Adelaide Subgroup bedrocks and are of widespread occurrence in the region. Their scientific and conservation value is assessed as low and therefore no special mitigation measures regarding them are proposed here. The overall palaeosensitivity of the solar power plant and grid connection project areas is assessed as low.

Potential impacts on palaeontological heritage during the construction phase of the renewable energy project are assessed as being of Low (Negative) significance without mitigation as well as following proposed mitigation. The latter comprises the implementation of a Chance Fossil Finds Procedure by the ECO during the Construction Phase, as outlined in Appendix 2 to this report. There is no preference for one or other of the two grid connection route options. The anticipated cumulative impact of the proposed or authorized solar power plant developments in the Virginia region - including the proposed Springbok Solar Power Plant - is assessed as Medium (negative) without mitigation, potentially falling to Low (negative) with full mitigation, given their comparatively small footprints compared

with the extensive outcrop areas of the fossiliferous rock units concerned (notably the Adelaide Subgroup). The No-Go Option would probably have a neutral impact significance.

There are no fatal flaws associated with the proposed solar power plant project from a palaeontological heritage viewpoint. There are no objections to authorization of the development, provided that the recommended mitigation measures (summarized in Tables 4 and 5) are incorporated into the EMPr for this project and fully implemented.

The ECO responsible for the construction phase of the project should be aware of the potential for important new fossil finds – most notably well-preserved vertebrate bones and teeth and large blocks of petrified wood - and the necessity to conserve them for possible professional mitigation. The ECO should monitor all site clearance and substantial excavations for fossil remains on an on-going basis during the construction phase (See Chance Fossil Finds Procedure outlined in Appendix 2). Recommended mitigation of chance fossil finds involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist, appointed by the developer, may be necessary, under a Fossil Collection Permit issued by the relevant heritage resources authority (*viz*. SAHRA). Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist.

1. PROJECT DESCRIPTION & BRIEF

The company Springbok Solar Power Plant (RF) (Pty) Ltd is proposing to develop a photovoltaic solar facility and associated infrastructure on the Farm Weltevrede No. 638, situated on the eastern bank of the Doringrivier approximately 10 km SW of Virginia and 23 km SSE of Welkom within the Matjhabeng Local Municipality, Free State Province (Figs. 1 to 3). The Springbok Solar Power Plant will have an installed capacity of up to 150 MW and a total development footprint of approximately 280 hectares (including supporting infrastructure on site). According to the Project Description Document prepared by Environamics Environmental Consultants (30 March 2021) the proposed renewable energy development will comprise the following key components:

- **PV Panel Array** - To produce up to 150MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a northern angle in order to capture the most sun, or using one-axis tracker structures to follow the sun to increase the Yield.
- **Wiring to Inverters** - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.
- **Connection to the grid** - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after

which the power will be evacuated into the national grid. Whilst Springbok Solar Power Plant (RF) (Pty) Ltd. has not yet received a cost estimate letter from Eskom, it is expected that generation from the facility will tie in with Theseus MTS 400/132/22kV Substation or to any of the existing 132Kv lines. The Project will inject up to 100MW into the National Grid. The installed capacity will be approximately 150MW.
There are two possible connection line routes proposed to the Theseus MTS 400/132/22kV Substation. Option 1 (preferred) is approximately 5.25km and option 2 (alternative) is approximately 5.3km long. Both options are located north-east of the project footprint (Figs. 1 & 3). The proposed power line routes are assessed here within a 100m wide corridor.

- **Electrical reticulation network_–** An internal electrical reticulation network will be required and will be laid ~2-4m underground, as far as practically possible.
- **Supporting Infrastructure –** The following auxiliary buildings with basic services including water and electricity will be required on site:
  - Office (~200m²);
  - Switch gear and relay room (~400m²);
  - Staff lockers and changing room (~200m²); and
  - Security control (~60m²)
- **Battery storage** – A Battery Storage Facility with a maximum height of 8m and a maximum volume of 1740m^3 of batteries and associated operational, safety and control infrastructure.
- **Roads** –Access will be obtained *via* a gravel road off the R730 Regional Route. An internal site road network will also be required to provide access to the solar field and associated infrastructure. The access and internal roads will be constructed within a 25-meter corridor.
- **Fencing** - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height of 2.5 meters will be used.

Further technical details for the project are outlined in Table 1 below (likewise abstracted from the Project Description Document prepared by Environamics Environmental Consultants).

The term project area in this report refers to the solar power plant on the Farm Weltevrede No. 638 as well as the associated grid connection to the Theseus MTS 400/132/22kV Substation.

Table 1: Technical details for the proposed Springbok Solar Power Plant

Component	Description / dimensions
Height of PV panels	6 meters
Area of PV Array	280 Hectares (Development footprint)
Number of inverters required	Minimum 50
Area occupied by inverter / transformer stations / substations / Battery Energy Storage System (BESS)	Central inverters+ LV/MV trafo: 20 m^2 HV/MV substation with switching station: 15 000 m^2 BESS: 4 000 m^2
Capacity of on-site substation	Minimum 130MVA in HV/MV substation

Area occupied by both permanent and construction laydown areas	Permanent Laydown Area: 280 Hectares Construction Laydown Area: ~2000 m^2
Area occupied by buildings	Security Room: ~60 m^2 Office: ~200 m^2 Staff Locker and Changing Room: ~200 m^2
Battery storage facility	Maximum height: 8 m Maximum volume: 1740 m^3
Length of internal roads	Approximately 15 km
Width of internal roads	Between 6 & 12 meters
Proximity to grid connection	Approximately 5 kilometers
Height of fencing	Approximately 2.5 meters

According to the Environmental Screening Report prepared for the proposed solar facility by Environamics (through the use of the Department of Forestry, Fisheries and the Environment Screening Tool) the project area is of Medium to Very High Palaeosensitivity (Fig. 18). The present combined desktop and field-based palaeontological heritage assessment has accordingly been commissioned on behalf of the proponent as part of the EIA Process for the development by the responsible independent EAP, Environamics Environmental Consultants, Potchefstroom (Contact details: Christia van Dyk. Environamics Environmental Consultants, 14 Kingfisher Street, Tuscany Ridge Estate, Potchefstroom, 2531. Telephone: 086 762 8336. Cell: 083 450 0406. Electronic Mail: christia@environamics.co.za). This report will contribute to the overarching Heritage Impact Assessment as well as the Environmental Management Programme (EMPr) for the solar plant development.

1.1. Brief for the palaeontological study

1.1.1. General requirements

Specialists' reports must be aligned with Appendix 6 of GNR326 published under sections 24(5), and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and whereby the following are to be included:

- The details of-
  - the specialist who prepared the report; and
  - the expertise of that specialist to compile a specialist report including a curriculum vitae;
- A declaration that the specialist is independent in a form as may be specified by the competent authority;
- An indication of the scope of, and the purpose for which, the report was prepared;
  - An indication of the quality and age of base data used for the specialist report;
  - A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;
- The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;

- Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;
- An identification of any areas to be avoided, including buffers;
- A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities;
- Any mitigation measures for inclusion in the EMPr;
- Any conditions for inclusion in the environmental authorisation;
- Any monitoring requirements for inclusion in the EMPr or environmental authorisation;
- A reasoned opinion-
  - whether the proposed activity, activities or portions thereof should be authorised;
    - regarding the acceptability of the proposed activity or activities; and
  - if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- A description of any consultation process that was undertaken during the course of preparing the specialist report;
- A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- Any other information requested by the competent authority.

In addition to the above, specialists are expected to:

- Identify any issue or aspect that needs to be assessed and provide expert opinion on any issue in their field of expertise that they deem necessary in order to avoid potential detrimental impacts;
- Assess the degree and extent of all identified impacts (including cumulative impacts) that the preferred project activity and its proposed alternatives, including that of the no-go alternative, may have;
- Identify and list all legislation and permit requirements that are relevant to the development proposal in context of the study;
- Reference all sources of information and literature consulted; and
- Include an executive summary to the report.

1.1.2. Terms of reference for the paleontological heritage assessment

The scope of work for the palaeontological assessment study will consist of:

- A desktop investigation of the area, in which all geological maps, published scientific literature, previous paleontological impact studies in the same region and the author’s field of experience (consultation with professional colleagues as well as examination of institutional fossil collections and data) should be studied and used.

- Based on the outcome of the screening report , the need for a field assessment must be determined. The desktop investigation must be supplemented with a field assessment if required.
- Assess the potential impacts, based on a supplied methodology.
- Describe mitigation measures to address impacts during the construction, operation and decommissioning stages.
- Describe cumulative impacts of the project on paleontological resources in both the local study area regional study area and the proponent's plans to manage those effects.
- Supply the client with geo-referenced GIS shape files of any sensitive areas.

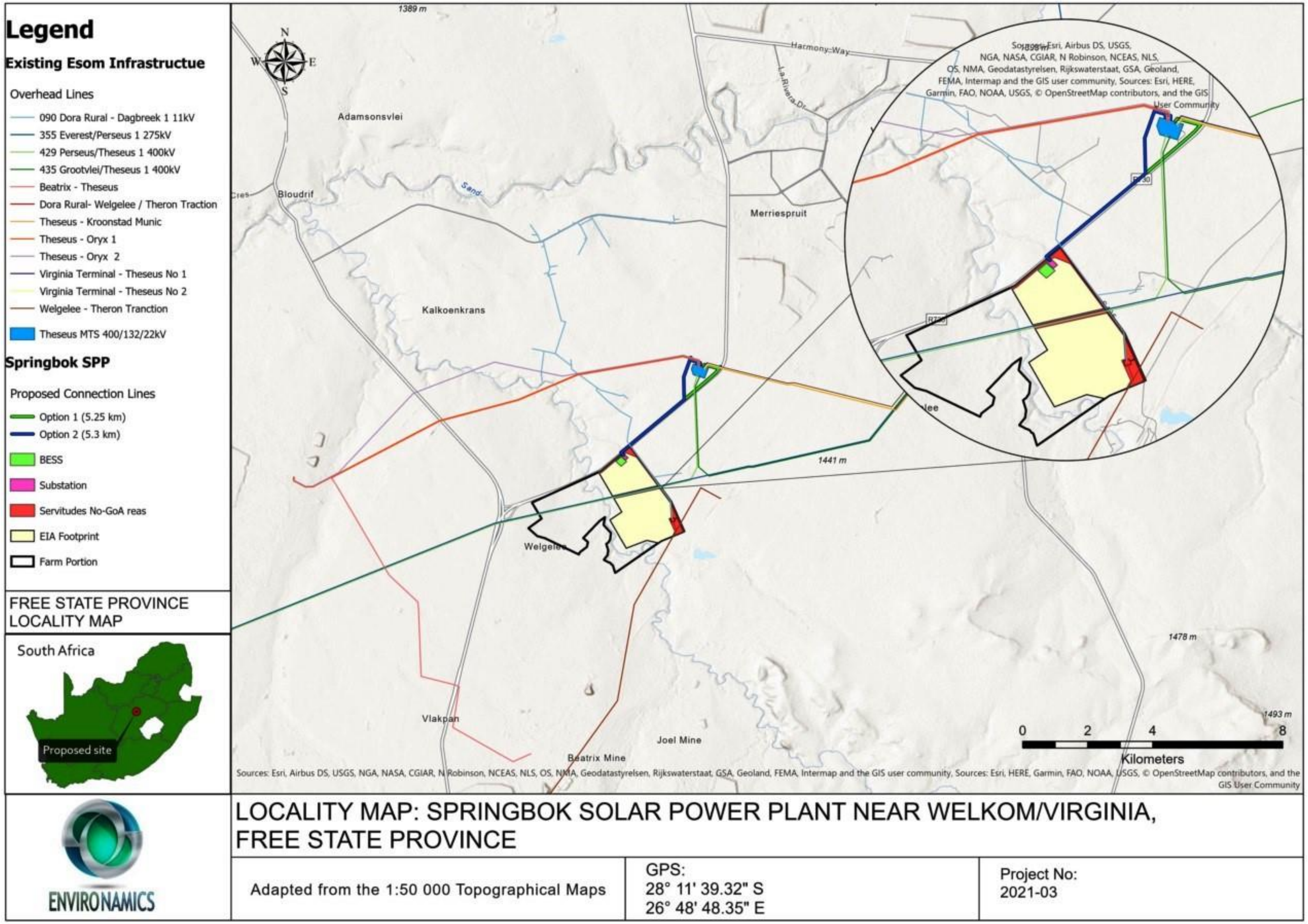

Figure 1: Locality map for the proposed Springbok Solar Power Plant on the Farm Weltevrede No. 638 near Virginia, Free State Province with detail of grid connection options under consideration (Image supplied by Environamics Environmental Consultants).

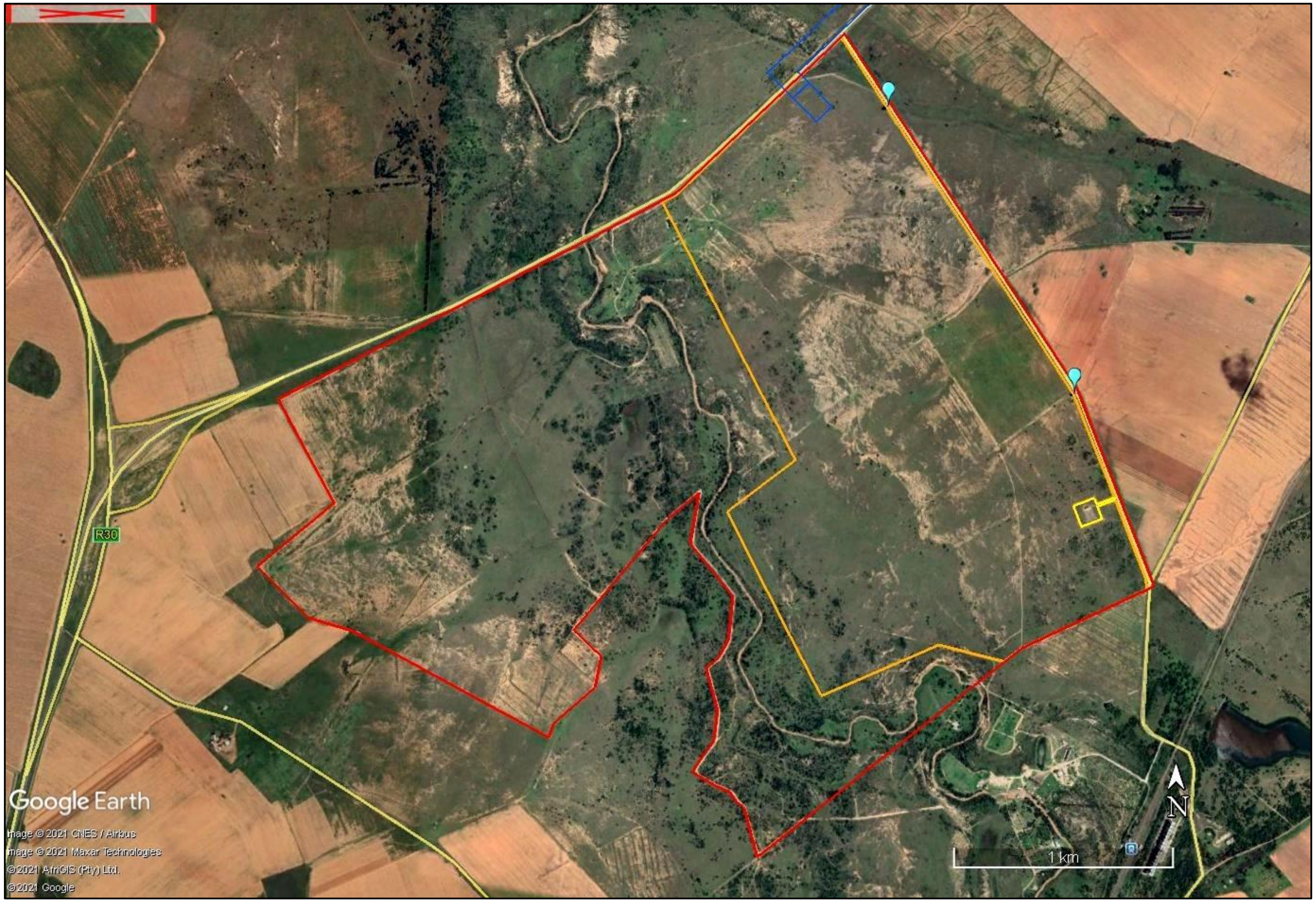

Figure 2: Google Earth© satellite image showing the Springbok Solar Power Plant project area (orange polygon) on the Farm Weltevrede No. 638 (red polygon), situated east of the Doringrivier and south of the R370 some 10 km SSW of Virginia, Free State Province. Access points are indicated by the blue symbols.

Figure 3: Google Earth© satellite image showing the 100 m-wide assessment corridors (blue polygons) for alternative grid connection options (each *c*. 5 km long) between the proposed Springbok Solar Power Plant on the Farm Weltevrede No. 638 and the existing Theseus MTS 400/132/22kV Substation.

2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE STUDY

The approach to this palaeontological heritage study is briefly as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous assessments of the broader study region, and the author's field experience and palaeontological database. Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed with recommendations for any further studies or mitigation.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience. Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report. This data is then used to assess the palaeontological sensitivity of each rock unit to development. The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any monitoring or mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phases. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for palaeontological collection permits from the relevant heritage management authorities, *i.e.* SAHRA for the Free State (Contact details: SAHRA, 111 Harrington Street, Cape Town. P.O. Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

GPS data for some geological and all fossil localities mentioned in the text and figure legends are provided separately in Appendix 1 to this report.

2.1. Information sources

The information used in this palaeontological heritage study was based on the following:

1. A short project description, maps and kmz files provided by Environamics Environmental Consultants, Potchefstroom;

2. A review of the relevant satellite images, topographical maps and scientific literature, including published geological maps and accompanying sheet explanations, as well as several previous desktop palaeontological assessment studies in the broader study region (*e.g.* Almond 2015, Brink undated, Groenewald 2013b, Millsteed 2013b);

3. The author's previous field experience with the formations concerned and their palaeontological heritage;

4. A short (half-day) palaeontological field assessment of the solar plant project area in March 2021 by the author, including only a small part of the grid connection corridor (*N.B.* The majority of the grid connection corridor was assessed at desktop level which is considered sufficient given the low bedrock exposure levels here).

2.2. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the case of the present study area near Virginia in the Free State exposure of potentially fossiliferous bedrocks is limited due to the largely flat terrain, extensive soil cover and dense grassy vegetation during summer as well as disturbed, scrubby woodlands in riverine areas. However, it is considered that sufficient bedrock and cover sediment exposures were examined during the course of this study to assess the broader palaeontological heritage sensitivity of the study area. Comparatively few academic palaeontological studies or field-based fossil heritage impact studies have been carried out in the region, so any new data from impact studies here are of scientific interest.

2.3. Legislative context for palaeontological assessment studies

The proposed alternative energy project is located in an area that is underlain by potentially fossiliferous sedimentary rocks of Palaeozoic and younger, Late Tertiary or Quaternary, age (Sections 3 and 4). The construction phase of the proposed development will entail substantial excavations into the superficial sediment cover and into the underlying bedrock as well. These may include, for example, surface clearance and excavations for the PV panel footings, internal and access roads, underground cables, power line pylon footings, on-site electrical substation and BESS, auxiliary buildings and construction site camp. All these developments may adversely affect potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and decommissioning phases of the renewable energy facility are unlikely to involve further adverse impacts on local palaeontological heritage, however.

The various categories of heritage Resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage Resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) 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.

(4) No person may, without a permit issued by the responsible heritage Resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) 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

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage Resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage Resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage Resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013).

3. GEOLOGICAL CONTEXT

The solar power plant project area on the Farm Weltevrede No. 638 (Fig. 2) comprises low-relief terrain at elevations between 1320 and 1350 amsl. situated on the eastern side of the Doringrivier (a south bank tributary of the Sandrivier) and south of the R730. The R30 tar road between Welkom and Theunissen runs *c*. 3 km to the west. Bedrock exposure away from the river banks and bed is very low (with the exception of low dolerite dykes) due to pervasive, thick sandy to gravelly soils and dense grassy vegetation with bush clumps while denser scrubby bush and mixed acacia woodland border the project area towards the west (Figs. 5 to 7). The area is currently used for game farming and is partially disturbed by farm tracks and historical agricultural activity. The grid connection corridor (Fig. 3) extending north-eastwards towards the existing Theseus MTS 400/132/22kV Substation runs across low-relief ground between 1330 and 1360 m amsl. featuring low grassy vegetation and agricultural lands, crossed by a small drainage line in the southwest. Bedrock exposure here is also minimal to non-existent.

The geology of the Virginia region is depicted on 1: 250 000 sheet 2826 Winburg (Fig. 4). A short explanation for this sheet has been published by Nolte (1995). The project area on Farm Weltevrede No. 638 as well as the associated grid connection corridor are both underlain at depth by continental sediments of the **Adelaide Subgroup** (Lower Beaufort Group, Karoo Supergroup) that are probably Late Permian in age (Johnson *et al.* 2006). Due to poor bedrock exposure, the Adelaide Subgroup has not been differentiated into formations on the Winburg 1: 250 000 sheet. A short account of the sedimentology of these tabular, pale buff to whitish arkosic channel sandstones and grey-green overbank mudrocks with horizons of ferruginous carbonate diagenetic concretions is given by Nolte (1995) who infers a braided river depositional setting. An interesting feature is the local occurrence of exotic (extra-basinal), cobble-sized clasts of granite, gneiss and quartzite suggesting a provenance to the east or southeast. The only good exposures of these rocks encountered close to (but just outside) the present study area occur in the bed and along the banks of the Doringrivier where flat-lying, pale, tabular, massive to cross-bedded sandstone bodies with locally gullied bases are interbedded with packages of weathered-looking, grey-green to khaki mudrocks and occasional thin crevasse-splay sandstones (Fig. 8).

Several narrow dykes with rubbly weathered tops of the **Karoo Dolerite Suite** of Early Jurassic age intrude and bake the Karoo bedrocks in the region. They protrude above the landscape as low ridges (Fig. 9) and many of them show a NW-SE or NE-SW trend. According the geological map and satellite imagery, the Beaufort Group bedrocks here are almost entirely covered by **Quaternary aeolian (wind-blown) sands** with thick (several meters) **Quaternary to Holocene alluvial deposits** along the banks of the Doringrivier and its tributaries (Fig. 13). Thick, orange to brownish sandy soils with sparse basal or dispersed gravels - including dolerite, ferruginised sandstone, hornfels, broken ferruginous carbonate concretions and petrified wood, with occasional flaked stone artefacts - are observed along farm tracks, clearings without vegetation and in erosion gullied areas (Figs. 6, 10 to 12).

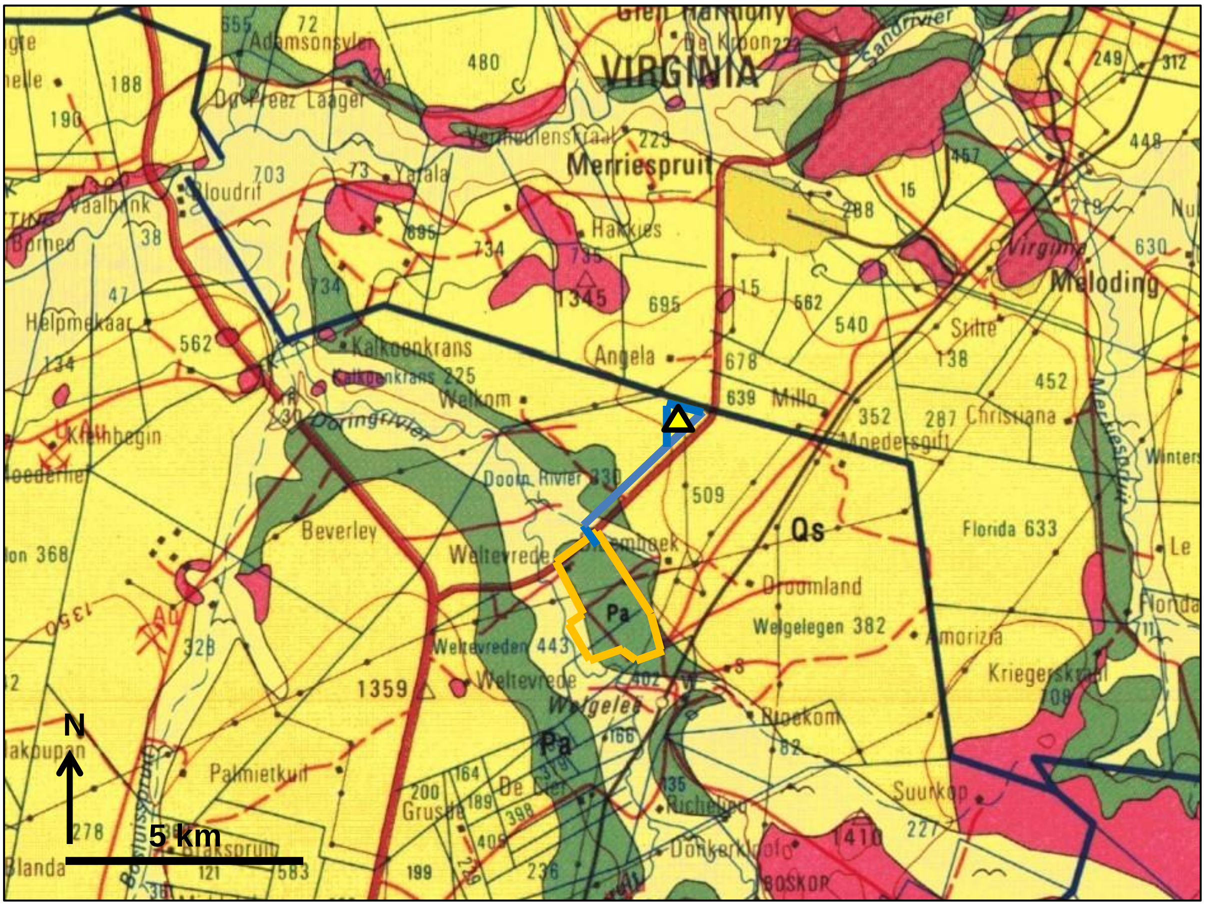

Figure 4: Extract from 1: 250 000 sheet 2826 Winburg (Council for Geoscience, Pretoria) *approximately* showing the project area for the proposed Springbok Solar Power Plant on the Farm Weltevrede No. 638 near Virginia (orange polygon) as well as the short (*c*. 5 km) grid connection corridor to the existing Theseus MTS 400/132/22kV Substation (blue line and polygon). The major lithostratigraphic rock units mapped here include: Adelaide Subgroup (Lower Beaufort Group, Karoo Supergroup) (Pa, dark green), dykes of the Karoo Dolerite Suite (Jd, thin red lines), Quaternary aeolian sands (Qs, dark yellow) as well as Late Caenozoic alluvial deposits along the banks of the Doringrivier (pale yellow).

Figure 5: View westwards across the Springbok Solar Power Plant project area showing flat to very gently-sloping, grassy terrain, lack of bedrock exposure and riverine woodland along the Doringrivier in the background.

Figure 6: Thick, well-sorted, orange-brown sandy aeolianites exposed in farm tracks within the solar project area.

Figure 7: Grassy vegetation and open acacia woodland on the western edge of the solar power plant project area.

Figure 8: Occasional good exposures of Adelaide Subgroup bedrocks – including pale, tabular channel sandstones and weathered, khaki mudrocks in the banks of the Doringrivier, outside and west of the solar power plant project area.

Figure 9: Low ridge of greyish, rubbly, weathered dolerite marking a narrow dyke intruding the more readily-weathered Adelaide Subgroup country rocks.

Figure 10: Thick, fine-grained, orange-hued aeolian sands exposed in erosion gullies. Such areas locally yield sparse blocks of reworked petrified wood (Loc. 125).

Figure 11: Open area of sandy alluvium just outside the zone of riverine woodland with sparse downwasted surface gravels, including occasional small blocks of petrified wood (Loc. 120).

Figure 12: Polygonally-jointed, well-consolidated alluvium (possibly Pleistocene in age) with downwasted surface gravels including small blocks of petrified wood as well as LSA stone artefacts (Hammer = 30 cm) (Loc. 121).

Figure 13: Thick sandy alluvium exposed in the well-vegetated banks of the Doringrivier west of and outside the solar power plant project area.

4. PALAEONTOLOGICAL HERITAGE

4.1. Fossils within Beaufort Group bedrocks

The Lower Beaufort Group is internationally famous for its rich fossil record of continental biotas of Middle to Late Permian age, including a wide range of terrestrial and freshwater vertebrates, vascular plants, palynomorphs and trace fossils (*cf* Kitching 1977, Keyser & Smith 1977-1978, MacRae 1999, McCarthy & Rubidge 2005, Johnson *et al.* 2006, Smith *et al.* 2012). While the Lower Beaufort Group (Adelaide Subgroup) beds near Virginia are not assigned to a specific formation on the published 1: 250 000 geological map, in terms of current mapping of the Main Karoo Basin fossil assemblage zones (AZs) the fossil biotas in this sector of the basin are assigned to the *Daptocephalus* Assemblage Zone (Smith *et al.* 2020, Viglietti 2020) (Fig. 14). Mapping of Karoo Basin fossil sites by Nicolas (2007) emphasizes the dearth of recorded fossil vertebrate remains in the northern Free State towards the north-western margins of the basin (Fig. 15). This is probably in large part due to the generally low levels of bedrock exposure in this region.

Recent authoritative reviews of fossil biotas within the *Daptocephalus* AZ (previously known as the *Dicynodon* AZ) have been provided by Smith *et al.* (2012) and Viglietti (2020). A short review of the palaeontology of the Beaufort Group in the Winburg 1: 250 000 sheet area is provided by Nolte (1995) who notes the abundant of petrified gymnosperm wood ("*Dadoxylon*") – including well-preserved tree trunks – in the Winburg and Senekal Districts (*cf* Botha & Visser 1970). Only a handful of tetrapod fossil sites are listed, based in part on Kitching (1977).

In the absence of good, fresh bedrock exposure, as in the present study area near Virginia, the main category of fossils found regionally comprises resistant-weathering blocks of petrified (silicified) wood that have been reworked by weathering and erosion into the overlying superficial sediments, *viz*. alluvium and downwasted surface gravels. Fossil wood (gymnosperm) taxa recorded from the *Daptocephalus* AZ include *Australoxylon* and *Prototaxoxylon* (Bamford 1999, 2004, 2016).

No fossils were recorded within Adelaide Subgroup bedrocks within the present study area since there is apparently very little or no surface exposure here. Limited exposures along the banks and bed of the Doringrivier outside the project area appear to be weathered, compromising fossil preservation, while dolerite intrusions may have further reduced the palaeosensitivity of the bedrocks regionally.

The mainly Pleistocene to Recent superficial deposits in the project area - viz. sandy soils, downwasted surface gravels, possible pedocretes (such as ferricretes) and alluvium – are poorly known in palaeontological terms. They are likely to be of Low to Very Low palaeosensitivity for the most part. However, these younger sediments may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (*e.g.* Cooke 1974, Skead 1980, Klein 1984, MacRae 1999, Partridge & Scott 2000, Churchill et al. 2000, Boshoff & Kerley 2013). These may include ancient human remains of considerable palaeoanthropological significance (*e.g*. Grine *et al.,* 2007). Other potential late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria and other insect burrows or nests, coprolites, rhizoliths), and plant remains such as peats or palynomorphs (pollens) in fine-grained, organic-rich alluvial horizons. Quaternary alluvial sediments may contain reworked Stone Age artifacts that are useful for constraining their maximum age.

Numerous small to medium-sized (up to 15 cm max. diam.), angular to subrounded blocks of well-preserved petrified wood were recorded within downwasted surface gravels overlying Late Caenozoic alluvium as well as within or overlying aeolian cover sands within the Springbok Solar Power Plant project area (Figs. 16 & 17) (See Appendix 1 for sample localities, including a satellite map). It is noted that these reworked fossils are of widespread occurrence within the Late Caenozoic superficial deposits and the recorded sites are only a small, albeit probably representative subsample of all possible sites within the solar power plant and grid conection project area (many or most of which are probably buried beneath the ground surface). Apart from reworked petrified wood, no further fossil remains were recorded within the superficial sediments within the project area. Since the scientific and conservation value of the fossil wood material is considered to be low, since it is out of context and of very widespread occurrence regionally, the palaeosensitivity of the solar power plant and grid connection project areas is assessed as LOW.

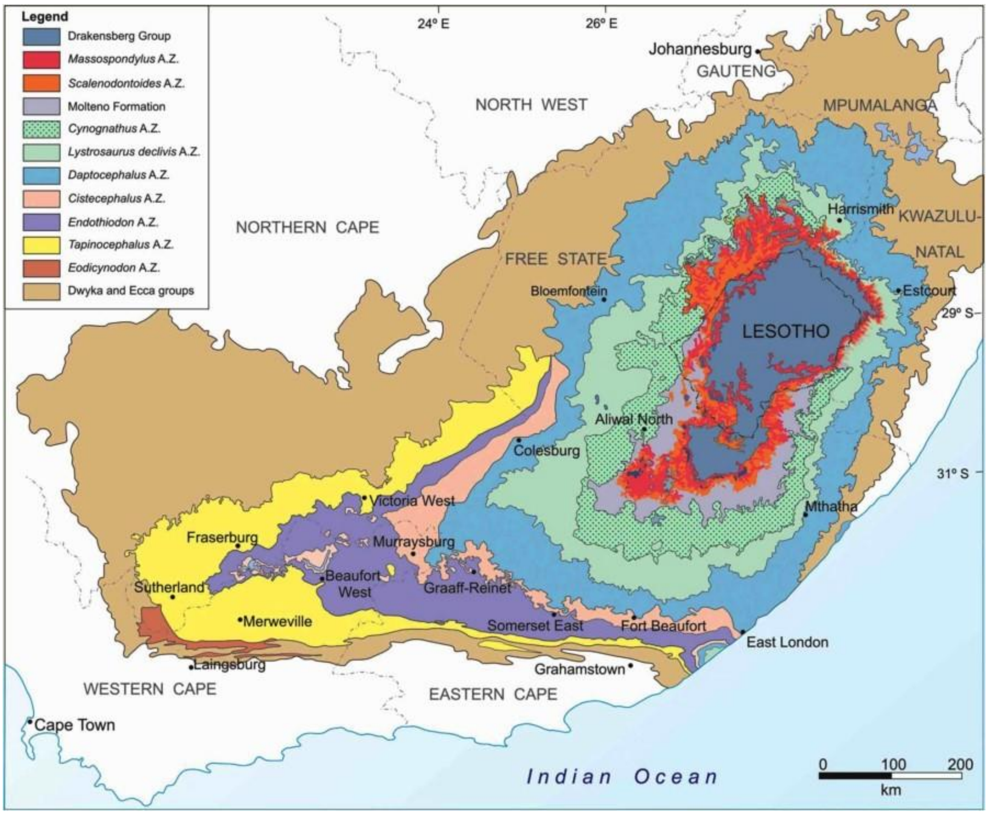

Figure 14: Latest map of fossil assemblage zones within the Beaufort and Stormberg Groups of the Main Karoo Basin of South Africa (From Smith *et al.* 2020). Adelaide Subgroup bedrocks underlying the Springbok Solar Power Plant to the NE of Bloemfontein, Free State, belong to the *Daptocephalus* Assemblage Zone (grey-blue) of Late Permian to Early Triassic age.

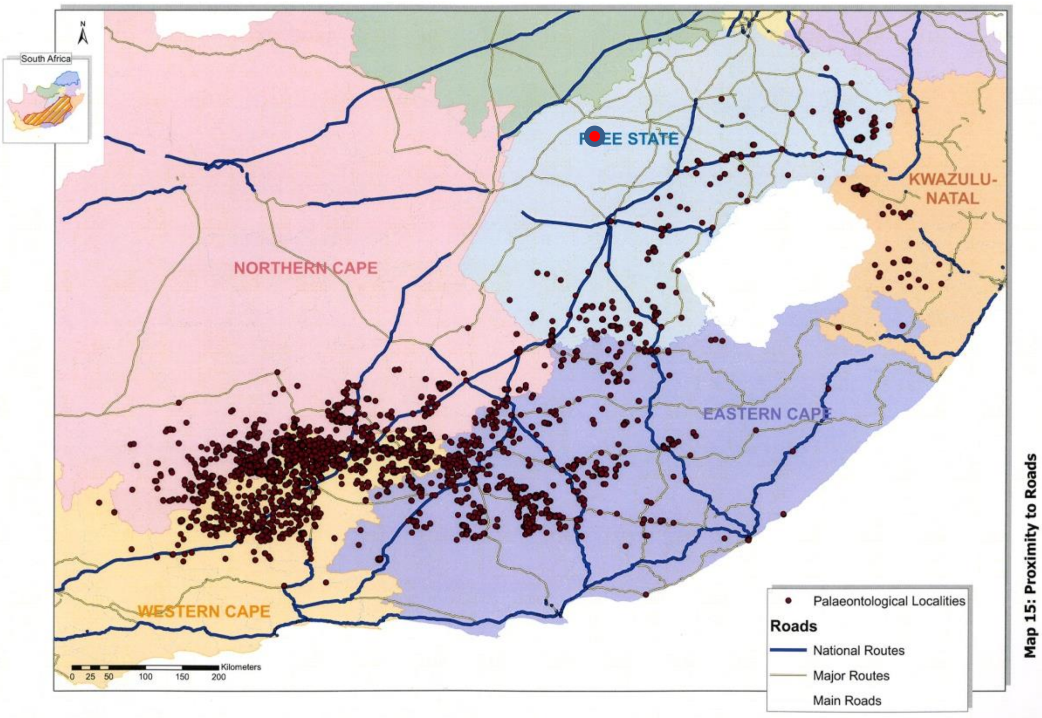

Figure 15: Map of Beaufort Group fossil tetrapod localities (from Nicolas 2007) showing the paucity of fossil records in the northern Free State region (red circle) where the present project area is located. This may be largely due to poor bedrock exposure levels in this sector of the Main Karoo Basin.

Figure 16: Angular, multi-hued and banded blocks of Beaufort Group petrified wood collected from among downwasted surface gravels at Loc. 117 (Scale in cm).

Figure 17: Range of petrified wood blocks among downwasted surface gravels at Loc. 118 (Scale in cm).

5. SITE SENSITIVITY VERIFICATION AND EVALUATION OF IMPACTS ON PALAEONTOLOGICAL HERITAGE

5.1. Site sensitivity verification

A MEDIUM to (mostly) VERY HIGH palaeosensitivity has been provisionally assigned to the Springbok Solar Power Plant project area on the Farm Weltevrede No. 638 and associated grid connection corridor near Virginia by the DFFE screening tool (Fig. 18, abstracted from the Screening Report for Environmental Authorisation prepared by Environamics Environmental Consultants, February 2021).

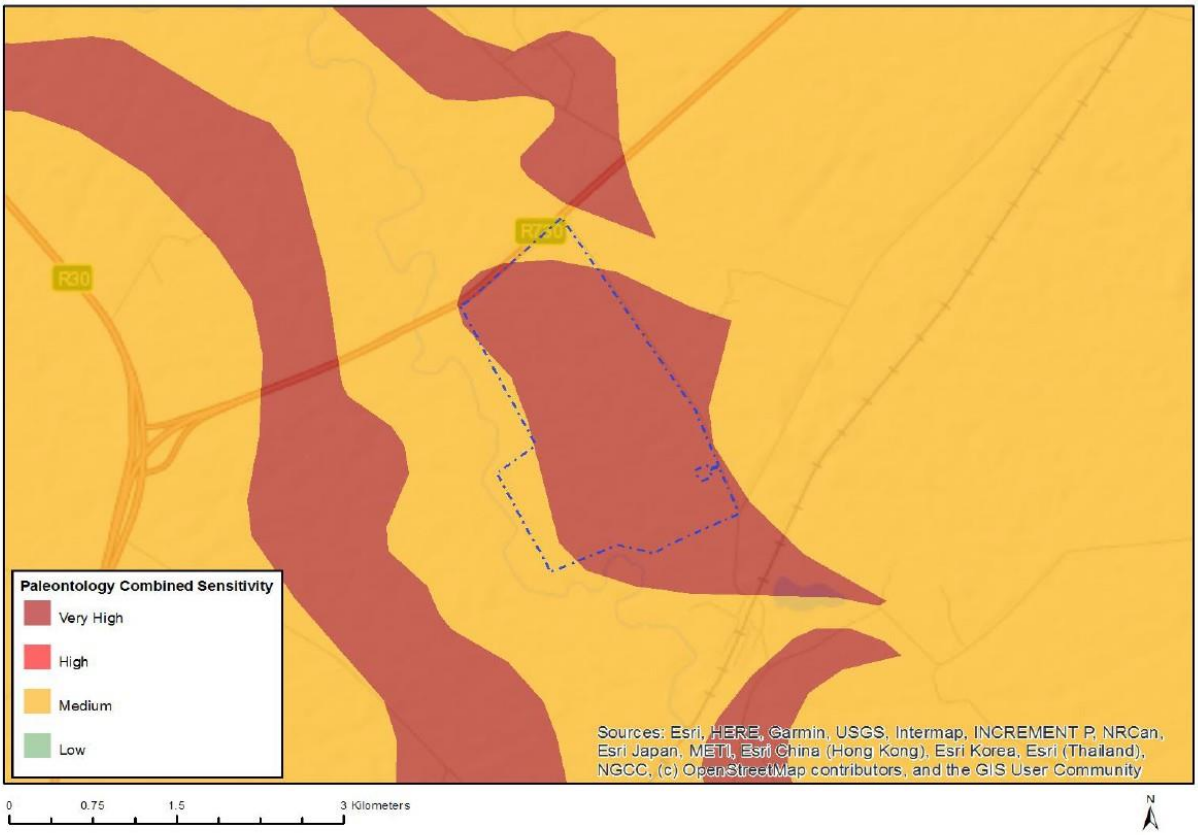

Figure 18: Palaeosensitivity map for the Springbok Solar Power Plant project area (blue dotted polygon) (Figure abstracted from the Screening Report for Environmental Authorisation prepared by Environamics Environmental Consultants). Most of the solar facility project area, including portions of the associated grid connection corridor extending to the NE, is provisionally mapped here as of Very High palaeosensitivity. A Low palaeosensitivity is inferred based on desktop and field data, however.

The originally proposed Medium to Very High palaeosensitivity of the Paleso Solar Power Plant project area is *contested* here. Rather, a generally LOW palaeosensitivity is assigned to this area in the present PIA report, largely based on:

- Very low exposure levels of potentially fossiliferous Beaufort Group bedrocks;
- High levels of weathering shown by bedrocks in the region, just outside the project area;

- Fossils (petrified wood) recorded within the project area are out of context (derived by weathering and erosion of underlying bedrocks) and of widespread occurrence regionally.

5.2. Impact assessment

The Springbok Solar Power Plant project area is located in a region that is underlain by fossiliferous sedimentary rocks of Palaeozoic and younger, Pleistocene to Holocene age (Sections 3 & 4). Existing impacts to palaeontological heritage within the project area are likely to be minimal, largely comprising occasional damage to fossilized wood exposed at the ground surface through game ranching activities, including vehicle use along farm tracks. These on-going impacts are offset by the slow exposure of fresh blocks of fossil wood through bedrock weathering.

The construction phase of the proposed solar energy facility and grid connection will entail substantial excavations into the superficial sediment cover and locally into the underlying bedrock as well. These include, for example, surface clearance and excavations for the PV panel footings, laydown areas, internal and access roads, underground cables, power line pylon footings, on-site electrical substation and battery storage facility, auxiliary buildings and construction camp. All these activities may adversely affect potential legally-protected fossil heritage within the project footprint as a result of excavations and surface disturbance (*e.g.* surface clearing and vehicle activity) during the construction phase by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good.

The inferred impact of the proposed PV solar plant and grid connection on legally-protected, local fossil heritage resources of scientific or broader conservation value is briefly evaluated here in Table 2. This assessment applies only to the *construction phase* of the development since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facilities are not anticipated. The assessment also applies equally to the PV solar project area as well as to the short associated 132 kV grid connection (as assessed within a 100m wide grid connection corridor, with two route options). Confidence levels in this assessment are *medium*, given (1) the limited palaeontological literature on the Palaeozoic bedrocks concerned in addition to (2) very low levels of bedrock exposure within the solar power plant and grid connection project areas and (3) the unpredictable distribution of well-preserved fossils in the subsurface.

As motivated in Table 2A, the impact significance of the proposed development in terms of palaeontological heritage is assessed as *Low (Negative)* without mitigation. Should the recommended mitigation measures for the construction phase of the solar facility development, as outlined in Section 6 (incl. Table 4) and Appendix 2 of this report, be consistently followed-through, the impact significance would remain *Low* (*Negative*) but would entail both positive and negative impacts. Residual negative impacts from inevitable loss of *some* valuable fossil heritage would be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation. The latter is a *positive* outcome because any new, well-recorded and suitably-curated fossil material from this palaeontologically little-known region would constitute a useful addition to our scientific understanding of the fossil heritage of the Beaufort Group in the Free State. The No-Go option would probably have a neutral impact significance; protection of local fossils from damage or destruction would be partially offset by natural surface weathering processes as well as lost opportunities to improve the palaeontological database through professional mitigation of chance fossil finds.

There is no preference for one or other of the two grid connection route options.

There are no fatal flaws associated with the proposed solar PV project from a palaeontological heritage viewpoint and no objects to authorisation of the development, provided that the recommended mitigation measures are fully implemented.

Table 2A: Evaluation of anticipated impacts on local palaeontological heritage resources due to the proposed Springbok Solar Power Plant near Virginia, Free State (Construction Phase)

Palaeontological Heritage Impacts*	Disturbance, damage or destruction of legally-protected fossil heritage within the development footprint during the construction phase	
	Pre-mitigation impact rating	**Post mitigation impact rating**
Status (positive or negative)	Negative	Negative / positive
Extent	Site (1)	Site (1)
Probability	Possible (2)	Unlikely (1)
Duration	Permanent (4)	Permanent (4)
Magnitude	Low (1)	Low (1)
Reversibility	Irreversible (4)	Irreversible (4)
Irreplaceable loss of resources	Marginal (2)	Marginal (2)
Cumulative impact	Low (3).	
Significance	**Negative low (16)**	**Negative low (15)**
Can impacts be mitigated?	Implementation of recommended Chance Fossil Finds Procedure.	

***** *N.B.* Refers essentially to impacts on well-preserved and / or rare fossils of scientific and conservation value.

5.2. Cumulative impact assessment

A tabulated summary of comparable renewable energy projects within a 30 km radius of the present project area near Virginia is presented in Table 3 and Figure 17 below (Data provided by Environamics Environmental Consultants). Based on the SAHRIS website, the only palaeontological heritage assessments (PIAs) available for this region (Almond 2015, Brink undated, Groenewald 2013b, Millsteed 2013b) are all at desktop level with no field data. While the potential for fossils within the Beaufort Group bedrocks is noted, a LOW palaeontological impact significance is inferred for most the projects concerned, given the extensive coverage by low sensitivity superficial sediments.

In the author's opinion:

- Palaeontological impact significances inferred for renewable energy projects, where these are assessed at all, may well reflect different assessment approaches rather than contrasting palaeontological sensitivities and impact levels;

- Meaningful cumulative impact assessments require comprehensive data on *all* major developments within a region, not just those involving renewable energy, as well as an understanding of the extent to which recommended mitigation measures are followed through;

- Trying to assess cumulative impacts on different fossil assemblages from different stratigraphic units (for example, Precambrian stromatolites from 2.6 billion years ago *versus* Pleistocene alluvial deposits less than 2.5 million years old) has limited value.

- Field-based (or even desktop) palaeontological data is not available for many or most of the relevant renewable energy projects, seriously limiting the value of any cumulative impact analysis.

Table 2B: Evaluation of anticipated cumulative impacts on local palaeontological heritage resources due to solar power developments in the Virginia region (Construction Phase)

Palaeontological Heritage Impacts*	Disturbance, damage or destruction of legally-protected fossil heritage within the development footprints during the construction phase	
	Pre-mitigation impact rating	**Post mitigation impact rating**
Status (positive or negative)	Negative	Negative / positive
Extent	Site (1)	Site (1)
Probability	Possible (2)	Possible (2)
Duration	Permanent (4)	Permanent (4)
Magnitude	Medium (2)	Low (1)
Reversibility	Irreversible (4)	Irreversible (4)
Irreplaceable loss of resources	Marginal (2)	Marginal (2)
Cumulative impact	Low (2).	
Significance	**Negative medium (30)**	**Negative low (15)**
Can impacts be mitigated?	Yes. • Protection of any recorded sensitive fossil sites through buffers and / or judicious professional collection: • ECO monitoring of surface clearance and excavations for fossil remains; • Implementation of recommended Chance Fossil Finds Procedure.	

***** *N.B.* Refers essentially to impacts on well-preserved and / or rare fossils of scientific and conservation value.

Given (1) the comparatively small combined footprint of the renewable energy projects under consideration compared with the very extensive outcrop areas of Lower Beaufort Group bedrocks as well as (2) the probable (albeit *unconfirmed*) rarity of scientifically valuable occurrences of well-preserved vertebrate and other fossils within flat-lying terrain preferred for solar energy projects, the cumulative impact of the proposed or authorized solar power plant developments in the Virginia region - including the proposed Springbok Solar Power Plant - is assessed as MEDIUM (negative) (without mitigation), potentially falling to LOW (negative) (with full mitigation) (See Table 2B). There are therefore no objections on palaeontological grounds to authorization of this project.

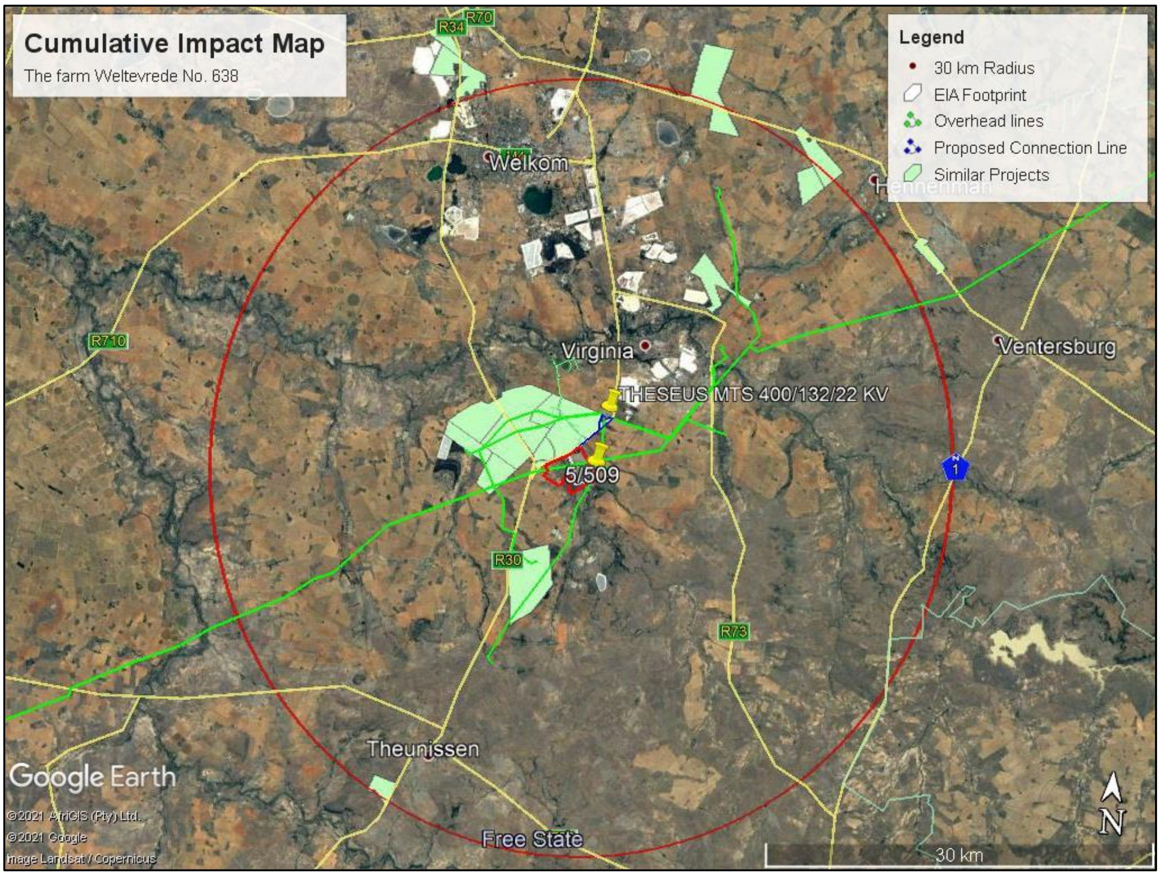

Figure 19: Map of renewable energy developments within a 30 km radius of the Springbok Solar Power Plant (Image provided by Environamics Environmental Consultants). PIA reports for a minority of these projects are currently available, and all of these are at a desktop level.

Table 3: Summary of related renewable energy projects within a 30 km radius of the Springbok Solar Power Plant project area that may contribute to cumulative impacts (Data collated by Environamics Environmental Consultants).

Site name	Distance from study area	Proposed generating capacity	DEFF reference	EIA process	Project status
Kalkoenkrans	2.6 km	19 MW	12/12/20/2669	BAR	Approved
Palmietkuil 328	4.7 km	19.9 MW	12/12/20/2666/A	BAR	Approved
Leeubult 52	5.7 km	19.9 MW	12/12/20/2668	BAR	Approved
Palmietkuil 328	4.7 km	19 MW	12/12/20/2666	BAR	Approved
Leeubult	5.7 km	14 MW	12/12/20/2667	BAR	Approved
Onverwag NO. 728 and PTN 2 of the farm Vaalkranz NO. 220,	17 km	75 MW	14/12/16/3/3/2/580	EIA	In Process
Oryx solar energy facility	2 km	75 MW	14/12/16/3/3/2/526	Scoping and EIA	In Process
Sonvanger PV	28 km	75 MW	14/12/16/3/3/2/672	Scoping and EIA	In Process
Everest Solar PV	29 km	75 MW	14/12/16/3/3/2/512	Scoping and EIA	In Process
Uitkyk RE/509, Helderwater RE/494 and Doornpan 1/426	29 km	75 MW	14/12/16/3/3/2/581	Scoping and EIA	In Process

6. RECOMMENDATIONS FOR MONITORING AND MITIGATION

Proposed monitoring and mitigation measures for the Springbok Solar Power Plant, to be incorporated into the Environmental Management Programme for the renewable energy development, are summarized in Tables 4 and 5.

Although fossil wood is widely scattered within the project area, the great majority of occurrences here are considered to be of low conservation or scientific value and no special mitigation measures regarding them are proposed here.

No palaeontological No-Go areas or other fossil sites requiring specialist mitigation have been identified within the solar facility development footprint, including the associated grid connection corridor.

The ECO responsible for the construction phase of the solar facility should be aware of the potential for important fossil finds and the necessity to conserve them for possible professional mitigation. The ECO should monitor all substantial surface clearance operations and excavations into sedimentary rocks for fossil remains such as well-preserved fossil bones or wood on an on-going basis during the construction phase. A Chance Fossil Finds Procedure for this development is outlined in Appendix 2.

Recommended mitigation of chance fossil finds during the construction phase of the solar facility and associated grid connection involves safeguarding of the fossils (preferably *in situ*) by the responsible ECO and reporting of finds to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Where appropriate, judicious sampling and recording of fossil material and associated geological data by a qualified palaeontologist, appointed by the developer, may be required by the relevant heritage regulatory authorities. Any fossil material collected should be curated within an approved repository (museum / university fossil collection) by a qualified palaeontologist. These recommendations should be included within the Environmental Management Programme for the proposed renewable energy project.

7. ACKNOWLEDGEMENTS

Ms Christia Van Dijk and Ms Carli Steenkamp of Environamics Environmental Consultants, Potchefstroom are both thanked for commissioning this study and for providing the relevant background information. Additionally, I am grateful to Ms Lisa Opperman of Environamics for careful editorial work on the draft PIA reports and to Mr Nico Venter of Subsolar Energy, Pretoria for facilitating the palaeontological fieldwork.

Table 4: Proposed monitoring and mitigation measures for incorporation into the EMPr for the Springbok Solar Power Plant project (Construction phase)

POTENTIAL ASPECTS RESULTING IN POTENTIAL ENVIRONMENTAL IMPACT DURING CONSTRUCTION	RECOMMENDED MITIGATION MEASURES					
	Desired Outcomes	**Targets & Indicators**	**Management and mitigation measures**	**Timeframe**	**Responsibility**	**Monitoring**
Fossil Heritage Resources						
Disturbance, destruction or damage to fossils preserved at or below surface through surface clearance and excavations during construction phase.	Reporting of chance fossil finds to SAHRA for professional recording and sampling.	Areas of bedrock exposure. Superficial deposits (alluvium, soils, gravels) with fossil remains.	Monitoring of all major site clearance and excavation work for fossil remains. Substantial well-preserved fossils (vertebrate bones, teeth, large blocks of petrified wood) to be safeguarded, preferably *in situ*, and reported to SAHRA. Fossil recording and sampling.	On-going during construction phase. Following report of chance fossil finds.	ECO Developer to appoint palaeontologist following significant new fossil finds Professional palaeontologist.	Compliance to be verified by ECO.

Table 5: Summary of impacts and mitigation measures for the Springbok Solar Power Plant project (Construction Phase)

SPECIALIST STUDY	IMPACT	PRE-MITIGATION RATING	POST MITIGATION RATING	SUMMARY OF MITIGATION MEASURES
Palaeontological heritage	Disturbance, destruction or damage to fossils preserved at or below surface through surface clearance and excavations during construction phase.	Negative low	Negative low	• Monitoring of all major site clearance and excavation work for fossil remains by ECO. • Substantial well-preserved fossils (vertebrate bones, teeth, large blocks of fossil wood) to be safeguarded, preferably *in situ*, and reported by ECO to SAHRA. • Recording and sampling of significant new fossil finds by professional palaeontologist.

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9. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Mpumalanga, Free State, Limpopo, Northwest and Kwazulu-Natal under the aegis of his Cape Town-based company *Natura Viva* cc. He has been a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

John E. Almond

Dr John E. Almond.
Palaeontologist,
***Natura Viva* cc**

APPENDIX 1: GPS LOCALITY DATA

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx.

N.B. The sites recorded here are only a small, representative subsample of all similar fossil occurrences expected at or near-surface within the project area.

The recorded fossil sites are mapped below in Figure A1.

116	28 11 18.0 S 26 48 21.9 E	Numerous small blocks of petrified wood among downwasted gravels exposed in open area among grassy vegetation. Proposed Field Rating IIIC Local Resource. No mitigation required.
117	28 11 14.0 S 26 48 15.6 E	Numerous small to medium-sized (c. 10 cm wide) blocks of petrified wood among downwasted gravels exposed in farm tracks. Proposed Field Rating IIIC Local Resource. No mitigation required.
118	28 11 13.8 S 26 48 16.4 E	Numerous small to medium-sized (c. 10 cm wide) blocks of petrified wood among downwasted gravels exposed in farm tracks. Proposed Field Rating IIIC Local Resource. No mitigation required.
119	28 11 20.6 S 26 48 05.7 E	Small blocks of petrified wood among downwasted gravels exposed along edge of farm track. Proposed Field Rating IIIC Local Resource. No mitigation required.
121	28 11 21.2 S 26 48 04.3 E	Small blocks of petrified wood among downwasted gravels overlying well-consolidated, fine-grained, polygonally-cracked sandy sediment (debrite or modified alluvium) exposed along edge of farm track. Proposed Field Rating IIIC Local Resource. No mitigation required.
125	28 11 21.2 S 26 48 18.5 E	Thick, gullied, orange-brown sandy aeolianites with sparse dispersed gravels, including occasional blocks of reworked petrified wood. Proposed Field Rating IIIC Local Resource. No mitigation required.
126	28 11 30.4 S 26 48 30.1 E	Isolated block of petrified wood at surface among grass. Proposed Field Rating IIIC Local Resource. No mitigation required.
127	28 11 29.7 S 26 48 30.4 E	Isolated block of petrified wood at surface among grass. Proposed Field Rating IIIC Local Resource. No mitigation required.

Figure A1: Google Earth© satellite image of the Springbok Solar Power Plant project area (red polygon) showing numbered localities where reworked blocks of fossil wood have been recorded among surface gravels. The fossil material recorded here is not of high scientific or conservation interest (Proposed Field Rating IIIC). Therefore none of these sites requires mitigation, nor should they influence the final layout of the solar energy facility since the recorded sites are only a small, representative subsample of all similar fossils expected at or near-surface in the area. No fossil sites were recorded within the Beaufort Group bedrocks within the solar power plant or grid connection project areas where bedrock exposure is very low to non-existent.

<table>
<tr><td colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Springbok Solar Power Plant on Farm Weltevrede No. 638 near Virginia, Free State</td></tr>
<tr><td>Province & region:</td><td colspan="2">Free State: Matjhabeng Local Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">SAHRA, P.O. Box 4637, Cape Town 8000.
Contact: Dr Ragna Redelstorff. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za
or Ms Natasha Higgitt. Tel: 021 462 4502. Email: nhiggitt@sahra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Adelaide Subgroup (Beaufort Group) bedrocks, Pleistocene to Holocene aeolian sands, downwasted surface gravels</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Vertebrate bones, teeth, burrows, plant remains (especially petrified wood), trace fossils within Beaufort Group bedrocks.
Reworked petrified wood, vertebrate bones & teeth, vertebrate and other burrows (e.g. calcretised termitaria) within superficial sediments.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
• Context – describe position of fossils within stratigraphy (rock layering), depth below surface
• Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
• Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
• Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
• Photograph fossils against a plain, level background, with scale
• Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
• Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>