RECOMMENDED EXEMPTION FROM FURTHER PALAEONTOLOGICAL STUDIES:

PROPOSED BLOEMSMOND 3, BLOEMSMOND 4 AND BLOEMSMOND 5 SOLAR PV FACILITIES ON PORTIONS 5 AND 14 OF THE FARM BLOEMSMOND 455 NEAR UPINGTON AND THEIR CONNECTION TO THE NATIONAL GRID *VIA* THE UPINGTON MAIN TRANSMISSION SUBSTATION, ZF MGCAWU DISTRICT MUNICIPALITY, NORTHERN CAPE

John E. Almond PhD (Cantab.)
***Natura Viva* cc,**
PO Box 12410 Mill Street,
Cape Town 8010, RSA
naturaviva@universe.co.za

July 2019

EXECUTIVE SUMMARY

Project areas for three proposed 100 MW solar PV facilities (Bloemsmond 3, Bloemsmond 4 and Bloemsmond 5) on Portions 5 and 14 of Farm Bloemsmond 455 near Upington as well as the associated 132 kV grid connection are underlain by (1) unfossiliferous Precambrian basement rocks as well as (2) Late Caenozoic windblown sands, calcretes and alluvial deposits of the Kalahari Group. All these rock units are of low to very low palaeontological sensitivity and the impact significance of the proposed renewable energy developments is rated as LOW. Cumulative impacts of the developments in the context of other renewable energy projects in the Upington region are also rated as LOW. There are no preferences on palaeontological heritage grounds for any particular PV site or layout option under consideration. It is recommended that, pending the discovery of significant new fossils remains before or during construction, exemption from further specialist palaeontological studies and mitigation be granted for the proposed solar PV facilities as well as for the associated 132 kV grid connection to the Upington MTS. A Chance Fossil Finds Procedure for the construction phase is appended to this report.

1. OUTLINE OF THE PROPOSED DEVELOPMENT

In addition to the two authorised PV solar energy facilities on the property, it is proposed to develop three additional facilities, each of~ 100 MW generation capacity, on Portions 5 and 14 of the farm Bloemsmond 455, situated ~. 25 km to the southwest of Upington, ZF Mgcawu District Municipality, Northern Cape (Figs. 1 & 2). The three new renewable energy projects are:

- The **Bloemsmond Solar 3 PV Facility** to be developed on Portions 5 and 14 of Farm Bloemsmond 455 and with an estimated footprint of 310 hectares;
- The **Bloemsmond Solar 4 PV Facility** to be developed on Portions 5 and 14 of Farm Bloemsmond 455 and with an estimated footprint of 270 hectares;
- The **Bloemsmond Solar 5 PV Facility** to be developed on Portions 5 and 14 of Farm Bloemsmond 455 and with an estimated footprint of 340 hectares;

Each PV energy facility will consist of solar photovoltaic (PV) technology, fixed-tilt-, single-axis tracking- or dual-axis tracking- mounting structures, as well as associated infrastructure which will include:

- On-site switching-station / substation;
- Auxiliary buildings (gate-house and security, control centre, office, warehouse, canteen & visitors centre, staff lockers *etc*.);

- Inverter-stations, transformers and internal electrical reticulation (underground cabling);
- Access and internal road network (up to 15 km in length for the 3 PV facilities);
- Laydown area;
- Rainwater tanks; and
- Perimeter fencing and security infrastructure.

The separate on-site substations of the Bloemsmond 3, 4 & 5 PV facilities will be connected to the National Grid by a 132 kV transmission line to the Upington Main Transmission Substation (MTS) *via* the authorised 132 kV Bloemsmond Collector Substation (Fig. 2).

The present consolidated palaeontological heritage desktop assessment for the three new PV facilities as well as the grid connection has been commissioned on behalf of the clients by Cape EAPrac, George (Contact details: Mr Dale Holder. Cape EAPrac, 17 Progress Street, George. PO Box 2070, George 6530. Tel: 044 874 0365. E-mail: dale@cape-eaprac.co.za). It will contribute to the separate Basic Assessment process for each of the three PV facilities as well as to the Basic Assessment for the associated grid connection.

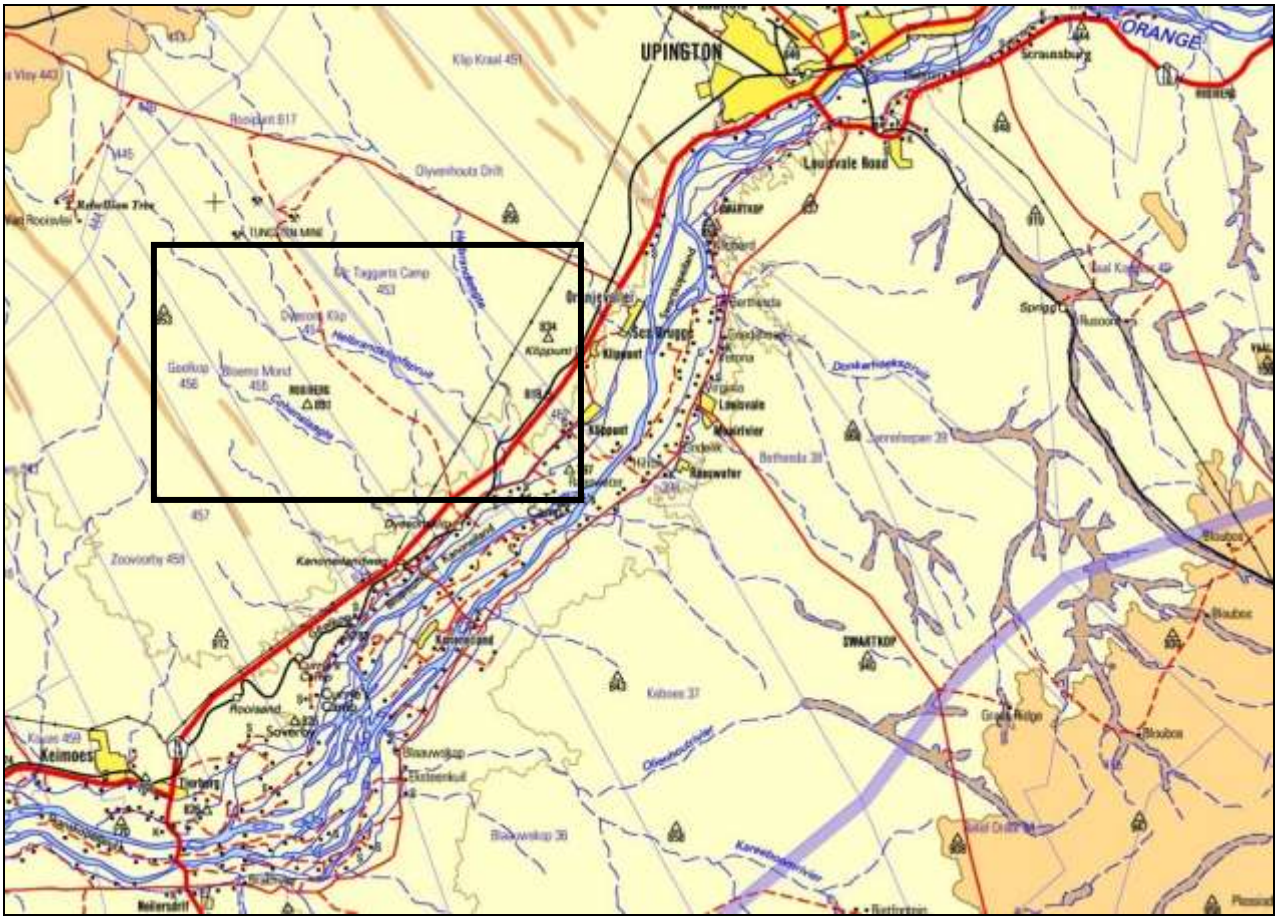

Figure 1. Extract from 1: 250 000 topographical map 2820 Upington (Courtesy of The Chief Directorate: National Geo-spatial Information, Mowbray) showing the *approximate* location (black polygon) of the combined project area for the proposed Bloemsmond 3, 4 and 5 Solar PV Facilities on the Farm Bloemsmond 455, *c*. 25 km SW of Upington, Siyanda District Municipality, Northern Cape, as well as that for the associated 132 kV grid connection to the Upington Main Transmission Substation (MTS) located some 10 km further to the east (See following figure for more detail of proposed development footprint).

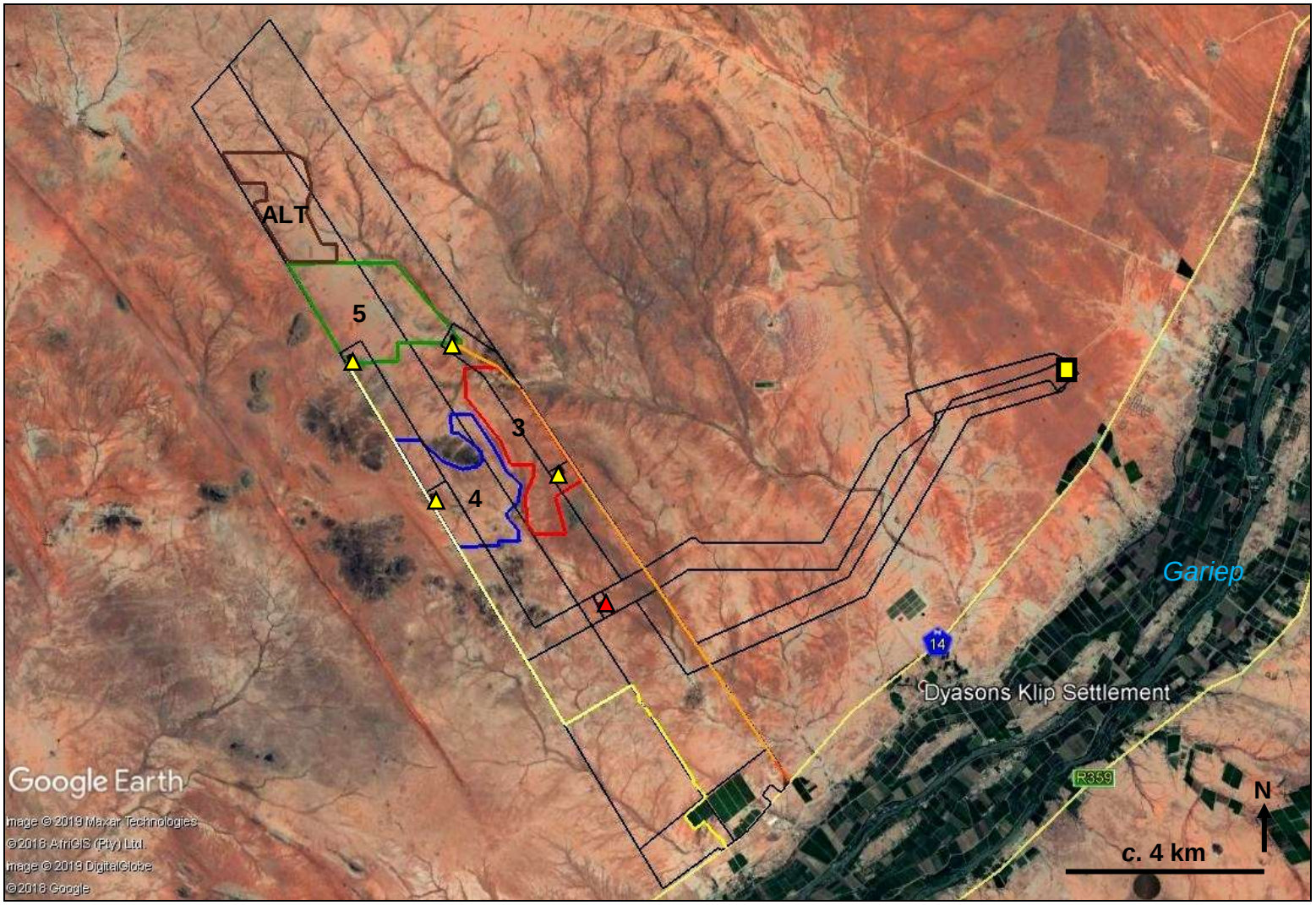

Figure 2. Google Earth© satellite image showing the location of the combined study area for the Bloemsmond 3 (red), 4 (blue) and 5 (green) Solar PV Facilities on the Farm Bloemsmond 455 near Upington, Northern Cape (black polygon). An alternative site for the three PV facilities is marked ALT (brown). Yellow triangles = site options for on-line substations. Red triangle = authorised 132 kV Bloemsmond Collector Substation. Yellow square = Upington Main Transmission Substation. 132 kV grid connection corridor options from the on-site substations to the MTS are shown in black. Access route alternatives are shown in yellow and orange.

2. GEOLOGICAL BACKGROUND

The combined Bloemsmond 3, 4 and 5 PV solar facility project area on Portions 5 and 14 of the farm Bloemsmond 455 is a narrow, NNW-SSE trending strip of fairly flat-lying, arid terrain at 880 to 760 m amsl that stretches away from the northern banks of the Gariep River *c*. 25 km SW of Upington, Northern Cape. The 132 kV grid connection corridor options to the Upington MTS traverse similar sandy to gravelly terrain NW of the Gariep River that is transected by several shallow, ephemeral water courses, including tributaries of the Cohensleegte, Helbrandkloofspruit and Helbrandleegte (Figs. 1 & 2).

The geology of the combined PV and grid connection project area near Upington is shown on the 1: 250 000 geology map 2820 Upington (Council for Geoscience, Pretoria; Fig. 3). A comprehensive sheet explanation for this map has been published by Moen (2007). The area is underlain at depth by a range of ancient Precambrian basement rocks – largely high grade metamorphic rocks (*e.g.* gneisses, metapelites) and intrusive granitoids – that belong to the **Namaqua-Natal Province** of Mid Proterozoic (Mokolian) age (Cornell *et al.* 2006, Moen 2007), such as the **Dyason's Klip Gneiss, Riemvasmaak Gneiss** and **Kanoneiland Granite**, among other units. These basement rocks are approximately two to one billion years old and entirely unfossiliferous (Almond & Pether 2008). They only crop out as small, isolated patches of basement rocks or low *Inselberge*. Over half of the study area is covered by fine-grained aeolian (wind-blown) sands of the **Gordonia Formation** (**Qg**, pale yellow in Fig. 3) as well as **Late Caenozoic calcretes** (**T**, dark yellow in Fig. 3). Prominent NW-SE trending linear dunes of orange-hued sands are clearly visible on satellite images of the region to the west of the study area. These superficial deposits are assigned to the Late Cretaceous to Recent Kalahari Group, the geology of which is reviewed by Thomas (1981), Dingle *et al.* (1983), Thomas & Shaw 1991, Haddon (2000) and Partridge *et al.* (2006). The Gordonia dune sands are considered to range in age from the Late Pliocene / Early Pleistocene to Recent, dated in part from enclosed Middle to Later Stone Age stone tools (Dingle *et al*., 1983, p. 291) while the Kalahari calcretes are probably for the most part also of Pleistocene or younger age. Additional Late Caenozoic superficial deposits present in the project area include **surface gravels** as well as **alluvial sands and gravels**, especially along drainage lines, which are not mapped at 1: 250 000 scale. Outcrops of Orange River alluvial deposits are not mapped within the project footprint.

3. PALAEONTOLOGICAL HERITAGE

The fossil heritage associated with each of the rock units represented in the Bloemsmond study area has been previously outlined in previous desktop studies for the region to the southwest of Upington by Almond (2014a, 2014b, 2015).

The igneous and metamorphic **basement rocks** are entirely unfossiliferous. The fossil record of the **Kalahari Group** is generally sparse and low in diversity. The **Gordonia Formation** dune sands were mainly active during cold, drier intervals of the Pleistocene Epoch that were inimical to most forms of life, apart from hardy, desert-adapted species. Porous dune sands are not generally conducive to fossil preservation. However, mummification of soft tissues may play a role here and migrating lime-rich groundwaters derived from the underlying bedrocks (including, for example, dolerite) may lead to the rapid calcretisation of organic structures such as burrows and root casts. Occasional terrestrial fossil remains that might be expected within this unit include calcretized rhizoliths (root casts) and termitaria (*e.g. Hodotermes*, the harvester termite), ostrich egg shells (*Struthio*) and shells of land snails (*e.g. Trigonephrus*) (Almond 2008, Almond & Pether 2008).

Other fossil groups such as freshwater bivalves and gastropods (*e.g. Corbula, Unio*) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with local watercourses and pans. Microfossils such as diatoms may be blown by wind into nearby dune sands. These Kalahari fossils (or subfossils) can be expected to occur sporadically but widely, and the overall palaeontological sensitivity of the Gordonia Formation is therefore considered to be low. Underlying calcretes of the **Mokolanen Formation** might also contain local concentrations of trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways, especially in areas associated with ancient wetlands.

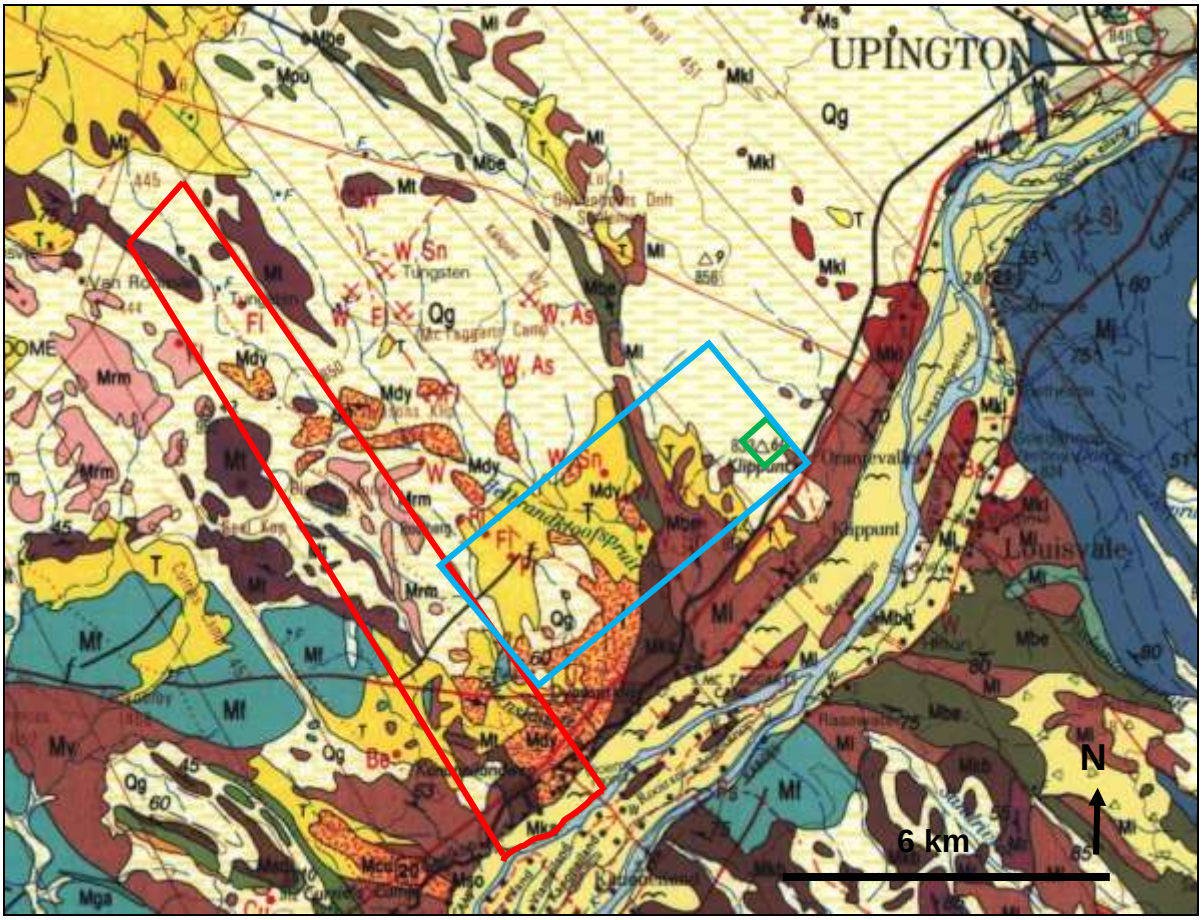

Figure 3. Extract from 1: 250 000 geological map 2820 Upington (Council for Geoscience, Pretoria) showing the location of Farm Bloemsmond 455 (red polygon), *c*. 25 km WSW of Upington, Northern Cape Province, where the Bloemsmond 3, 4 & 5 solar facilities will be located. The blue rectangle approximately encloses the additional study area for the associated 132 kV grid connection to the existing Upington MTS (small green square). The combined solar project and grid connection study area is underlain at depth by unfossiliferous Precambrian (Middle Proterozoic / Mokolian) basement rocks of the Namaqua-Natal Metamorphic Province, including a wide range of highly metamorphosed sediments and intrusive igneous rocks (*e.g.* Mdy – Dyason's Klip Gneiss; Mrm – Riemvasmaak Gneiss; Mka – Kanoneiland Granite). The basement rocks are extensively mantled by red aeolian (wind-blown) sand of the Gordonia Formation (Kalahari Group) (Qg, white with yellow stripes), Late Caenozoic calcretes (T, dark yellow), surface gravels as well as alluvial sands and gravels (several of these superficial deposits are not mapped at 1: 250 000 scale). The overall palaeontological sensitivity of the entire study area is rated as LOW.

4. CONCLUSIONS & RECOMMENDATIONS

The igneous and metamorphic Precambrian basement rocks underlying the Bloemsmond solar PV project and associated grid connection study area at depth are entirely unfossiliferous. The overlying Late Caenozoic aeolian sands, calcretes and stream gravels of the Kalahari Group mantling the older bedrocks are generally of low palaeontological sensitivity, although occasional concentrations of fossil material (*e.g.* mammalian bones and teeth, trace fossils) may occur here.

It is concluded that none of the proposed Bloemsmond 3, 4 and 5 Solar PV Facilities nor the associated 132 kV grid connections are likely to have significant impacts on local palaeontological heritage resources. This assessment applies equally to all grid connection route options, on-site substation sites and access roads under consideration. There is no preference on palaeontological heritage grounds to any specific layout option, including site alternatives for the PV facilities.

A considerable number of solar and other renewable energy developments have been proposed on both sides of the Gariep River in the Upington region of the Northern Cape, as shown on the SAHRIS website. However, few palaeontological assessment reports (PIAs) are available for these projects, including those in the vicinity of Farm Bloemsmond 455 (*e.g.* Durand 2013, Almond 2014a, 2014b, 2015). In all the reports examined, the palaeontological significance of the renewable energy project was assessed as low. Given the large outcrop area of the potentially-fossiliferous, but generally low-sensitivity, Kalahari Group, it is concluded that cumulative impacts of the proposed Bloemsmond solar PV facilities and associated grid connections in the context of other developments in the region are of LOW impact significance.

It is therefore recommended that, pending the discovery of significant new fossils remains before or during construction, exemption from further specialist palaeontological studies and mitigation be granted for the proposed Bloemsmond 3, Bloemsmond 4 and Bloemsmond 5 Solar PV Facilities on Farm Bloemsmond 455 near Upington, Northern Cape as well as for the associated 132 kV grid connection to the Upington MTS.

Should any substantial fossil remains (*e.g.* mammalian bones and teeth) be encountered during construction, however, these should be safeguarded, preferably *in situ*, and reported by the ECO to SAHRA, *i.e.* The South African Heritage Resources Authority, as soon as possible (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). This so that appropriate action can be taken by a professional palaeontologist, at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (*e.g.* stratigraphy, sedimentology, taphonomy) by a professional palaeontologist. A Chance Fossil Finds Procedure for the Upington study region is appended to this report.

5. KEY REFERENCES

ALMOND, J.E. 2008. Fossil record of the Loeriesfontein sheet area (1: 250 000 geological sheet 3018). Unpublished report for the Council for Geoscience, Pretoria, 32 pp.

ALMOND, J.E. 2014a. Proposed RE Capital 3 Solar Development on the property Dyason's Klip near Upington , Northern Cape. Palaeontological heritage basic assessment: desktop study, 13 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2014b. Proposed construction of RE Capital 11 photovoltaic solar facility on the remainder of the Farm Dyasonsklip 454, Upington, Northern Cape. Recommended exemption from further palaeontological studies, 6 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2015. Proposed AEP Bloemsmond Solar 1 & Solar 2 PV Facilities on the farm Bloemsmond 455 near Upington, Siyanda District Municipality, Northern Cape.Recommended exemption from further palaeontological studies, 6 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. & PETHER, J. 2008. Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc., Cape Town.

CORNELL, D.H., THOMAS, R.J., MOEN, H.F.G., REID, D.L., MOORE, J.M. & GIBSON, R.L. 2006. The Namaqua-Natal Province. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 461-499. Geological Society of South Africa, Marshalltown.

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

DURAND, J.F. 2013. Proposed solar energy facility at Tungsten Lodge near Upington, Northern Cape. Scoping report palaeontology, 10 pp.

HADDON, I.G. 2000. Kalahari Group sediments. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp. 173-181. Oxford University Press, Oxford.

MCCARTHY, T. & RUBIDGE, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

MOEN, H.F.G. 2007. The geology of the Upington area. Explanation to 1: 250 000 geology Sheet 2820 Upington, 160 pp. Council for Geoscience, Pretoria.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

THOMAS, M.J. 1981. The geology of the Kalahari in the Northern Cape Province (Areas 2620 and 2720). Unpublished MSc thesis, University of the Orange Free State, Bloemfontein, 138 pp.

THOMAS, D.S.G. & SHAW, P.A. 1991. The Kalahari environment, 284 pp. Cambridge University Press, Cambridge.

6. 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, Limpopo, Northwest, Mpumalanga, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has previously served as 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.

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

<table>
<tr><td colspan="3">CHANCE FOSSIL FINDS PROCEDURE: Bloemsmond 3, 4 & 5 solar facilities on Farm Bloemsmond 455 and associated grid connection near Upington</td></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape, Siyanda District Municipality</td></tr>
<tr><td>Responsible Heritage Resources Authority</td><td colspan="2">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</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Late Caenozoic alluvium along water courses and calcrete hardpans</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Bones, teeth and horn cores of mammals, freshwater molluscs, calcretised termitaria and other trace fossils</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 Authority 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 Authority 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 Authority and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Authority, 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 Authority</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 Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>