RECOMMENDED EXEMPTION FROM FURTHER PALAEONTOLOGICAL STUDIES & MITIGATION:

PROPOSED DANIËLSKUIL ROMA ENERGY SOLAR PLANT, KGATELOPELE LOCAL MUNICIPALITY, NORTHERN CAPE

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EXECUTIVE SUMMARY

The study area for the proposed Daniëlskuil Roma solar plant on Daniëlskuil Erf 753 (Portion of Erf 1) near Daniëlskuil, Kgatelopele Local Municipality, Northern Cape, is underlain at depth by Precambrian marine limestones of the Campbellrand Subgroup (Ghaap Group) that are known to contain horizons of well-preserved stromatolites (fossil microbial reefs) elsewhere in the Daniëlskuil – Lime Acres region of the Northern Cape. Nevertheless, the impact significance of the proposed solar plant development in terms of local fossil heritage resources is considered to be LOW because:

- The fossiliferous Precambrian bedrocks are largely mantled here by superficial sediments (*e.g.* wind-blown sands of the Kalahari Group) of low palaeontological sensitivity. Good surface exposures of stromatolitic limestone are not present here;
- The stromatolites within the Campbell Rand Subgroup are of widespread occurrence, and can be far better studied or sampled in large quarries near Daniëlskuil and at Lime Acres, some 15 km to the SSW, or at surface *c*. 7 km to the SW;
- Extensive, deep excavations into bedrock are unlikely to be involved in this sort of solar park project and the footprint is small.

It is therefore recommended that, pending the exposure of significant new fossils during development, exemption from further specialist palaeontological studies and mitigation be granted for this solar plant development.

There are no objections on palaeontological heritage grounds to authorisation of the proposed power plant. Should any substantial fossil remains (*e.g.* vertebrate bones and teeth, calcretised burrows) be encountered during excavation, however, these should be reported to SAHRA for possible mitigation by a professional palaeontologist (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za).

Cumulative impacts on fossil stromatolite occurrences within the Campbell Rand Subgroup in the Daniëlskuil region are likely to be already moderately high due to the large-scale mining here. *Additional* potential losses of fossil heritage posed by the construction of the Daniëlskuil Roma solar plant are unlikely to be significant. Current losses of Precambrian fossil heritage can be set against the probable widespread occurrence of stromatolitic beds in the subsurface of the extensive Ghaap Plateau (*i.e.* unique fossil heritage is not highly threatened). Furthermore, mining and other bedrock excavations may provide access for palaeontologists to previously inaccessible stromatolite beds. A premium should be set on the conservation of surface exposures of well-preserved stromatolites (such as seen *c*. 7 km SW of the Daniëlskuil Roma solar plant study area)

since partial surface weathering usefully enhances many of the stromatolitic features for scientific study (*cf* Almond 2015).

1. OUTLINE OF DEVELOPMENT

Roma Energy Daniëlskuil (Pty) Ltd is proposing to construct a 5 MW solar photovoltaic (PV) energy generation facility on Daniëlskuil Erf 753 (Portion of Erf 1). The study site is situated on the eastern side of the R31 tar road from Daniëlskuil to Douglas and directly east of the existing Idwala limestone mine on the southern outskirts of Daniëlskuil, Kgatelopele Local Municipality, Northern Cape (Fig. 2). The landowner is Idwala Industrial Holdings (Pty) Ltd, Danielskuil.

The proposed activity entails the construction of about 18540 PV solar panels with a footprint of less than 20 ha. The PV panels will be mounted on pedestals drilled and set into the ground. Extensive bedrock excavations are not envisaged, but some vegetation will need to be cleared from the site. Associated infrastructure includes a perimeter access road, single track internal access roads, trenches for underground cables, 2 to 4 transformer pads, a switching station, a maintenance shed, and a temporary construction camp. The Ouplaas 132/22kV substation is situated on site.

The present palaeontological heritage comment has been commissioned by EnviroAfrica cc, Somerset West as part of a comprehensive Heritage Impact Assessment of the proposed development (Contact details: Mr Bernard de Witt, EnviroAfrica cc, P. O. Box 5367, Helderberg, 7135; 29 St James St, Somerset West; mobile: +27 82 4489991; tel: +27 21 851 1616; fax: 086203308).

1.1. Legislative Framework

The present palaeontological heritage assessment report contributes to the consolidated Heritage Impact Assessment for the proposed solar plant and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme (EMPr) for this alternative energy project.

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; and
- 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 Heritage Western Cape, HWC (2016) and the South African Heritage Resources Agency, SAHRA (2013).

1.1. Study approach and methodology

Due to (1) the small footprint of the proposed solar plant development as well as (2) the inferred low palaeontological sensitivity of the study area based on previous field-based assessments by the author in the region (*e.g.* Almond 2013, 2014), only a desktop palaeontological impact assessment is submitted here.

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 (provisional tabulations of palaeontological sensitivity of all formations in the Northern Cape have already been compiled by Almond & Pether (2008); see also the palaeosensitivity maps provided on the SAHRIS website). The likely impacts of the proposed development on local fossil heritage are 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-based assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation or monitoring required before or during the construction phase of the development.

1.3. Limitations of this study

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 Daniëlskuil in the Northern Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation. However, bedrock exposure is highly constrained by extensive superficial deposits, especially in such areas of low relief, and there has been little formal palaeontological fieldwork in this area,

including within substantial local mining areas exploiting fossiliferous bedrocks. Confidence levels for this impact assessment are consequently rated as *medium*.

2. GEOLOGICAL BACKGROUND

The proposed Daniëlskuil Roma Solar Plant study area (See yellow polygon in satellite image Fig. 2; *c*. 28˚ 13' S, 23˚ 33' E) on Daniëlskuil Erf 753 is situated on the southern outskirts of the town of Daniëlskuil, Kgatelopele Local Municipality, Northern Cape. The site lies on the eastern side of the R31 tar road to Douglas and directly east of the Idwala limestone mine on the far side of the road. The area is flat-lying and situated at around 1460 m amsl. Shallow water courses run to the southwest and 1.3 km to the east, but outside the area. Satellite images as well as field photographs kindly provided by Jonathan Kaplan of ACRM, Cape Town, indicate that levels of bedrock exposure are low in this region, with occasional exposures of karst-weathered limestone in higher lying areas.

The geology of the study area near Daniëlskuil is shown on the 1: 250 000 geology map 2822 Postmasburg (Council for Geoscience, Pretoria; Fig. 1 herein). A very brief sheet explanation only is printed on the map itself. The proposed solar plant is underlain by Precambrian (Early Proterozoic) carbonate rocks of the **Campbell Rand Subgroup** (Ghaap Subgroup, Transvaal Supergroup) and in particular the **Kogelbeen Formation** (**Vgl**) which is exploited at the Idwala limestone mine to the west. The Kogelbeen Formation, some 300-440 m thick, consists of a succession of dolomites, limestones and minor secondary (replacement) cherts. Domal and columnar stromatolites (microbial mounds); microbial laminites and oolitic facies are common. The Lime Acres Member at the top of the Kogelbeen succession has been described in some detail by Altermann & Wotherspoon (1995) and is a major target for limestone mining in the region.

The Precambrian sedimentary rocks within the study area are largely mantled with a spectrum of other coarse to fine-grained **superficial deposits** including **windblown sand** (**Qs** in Fig. 1) and perhaps also alluvium of intermittently flowing streams. These deposits are generally young (Quaternary to Recent) and largely unfossiliferous (Partridge *et al.* 2006, Almond & Pether 2008).

3. PALAEONTOLOGICAL HERITAGE

The fossil record of the Precambrian sediments of the Northern Cape has been briefly reviewed by Almond & Pether (2008). The shallow shelf and intertidal sediments of the carbonate-dominated lower part of the **Ghaap Group**, including the **Campbell Rand Subgroups**, are famous for their rich fossil biota of *stromatolites* or microbially-generated, finely laminated mounds and branching structures. Some stromatolite occurrences on the Ghaap Plateau of the Northern Cape are spectacularly well-preserved (*e.g.* Boetsap locality figured by McCarthy & Rubidge 2005, Eriksson *et al.* 2006). Detailed studies of these 2.6-2.5Ga (billion year old) carbonate sediments and their stromatolitic biotas have been presented by Young (1932), Beukes (1980, 1983), Eriksson & Truswell (1974), Eriksson & Altermann (1998), Eriksson *et al.* (2006), Altermann and Herbig (1991), Altermann and Wotherspoon (1995). The older Archaean stromatolite occurrences from the Ghaap Group have been reviewed by Schopf (2006, with full references therein).

The **Kogelbeen Formation** features cyclical arrays of domal as well as columnar stromatolites as well as high-energy oolites and flat microbial laminites (Eriksson *et al.* 2006). An important fossil stromatolite site in the Lime Acres Member towards the top of the Kogelbeen succession occurs at Lime Acres situated only some 15 km south-southwest of the Daniëlskuil study area (Altermann & Wotherspoon 1995). Some of the oldest known (2.6 Ga) fossil microbial assemblages with filaments and coccoids have been recorded from stromatolitic cherty limestones of the Lime Acres Member, Kogelbeen Formation at Lime Acres (Altermann & Schopf 1995).

The **wind-blown sands** mantling the Precambrian carbonates in the study area are of low palaeontological sensitivity. A wide range of fossils are recorded from the Kalahari Group as a

whole, including palynomorphs, root casts (rhizomorphs) and invertebrate burrows (*e.g.* calcretised termitaria), rare vertebrate remains (mammals, fish, ostrich egg shell *etc*), diatom-rich limestones, freshwater stromatolites, freshwater and terrestrial shells (gastropods, bivalves), ostracods, charophytes (Almond & Pether 2008). However, the unconsolidated Quaternary to recent aeolian sands of the Gordonia Formation are generally very sparsely fossiliferous, while the fossils found in this unit are mainly of widespread occurrence.

The overall palaeontological sensitivity of the Daniëlskuil Roma Solar Plant study area at Daniëlskuil is assessed as LOW (see discussion below).

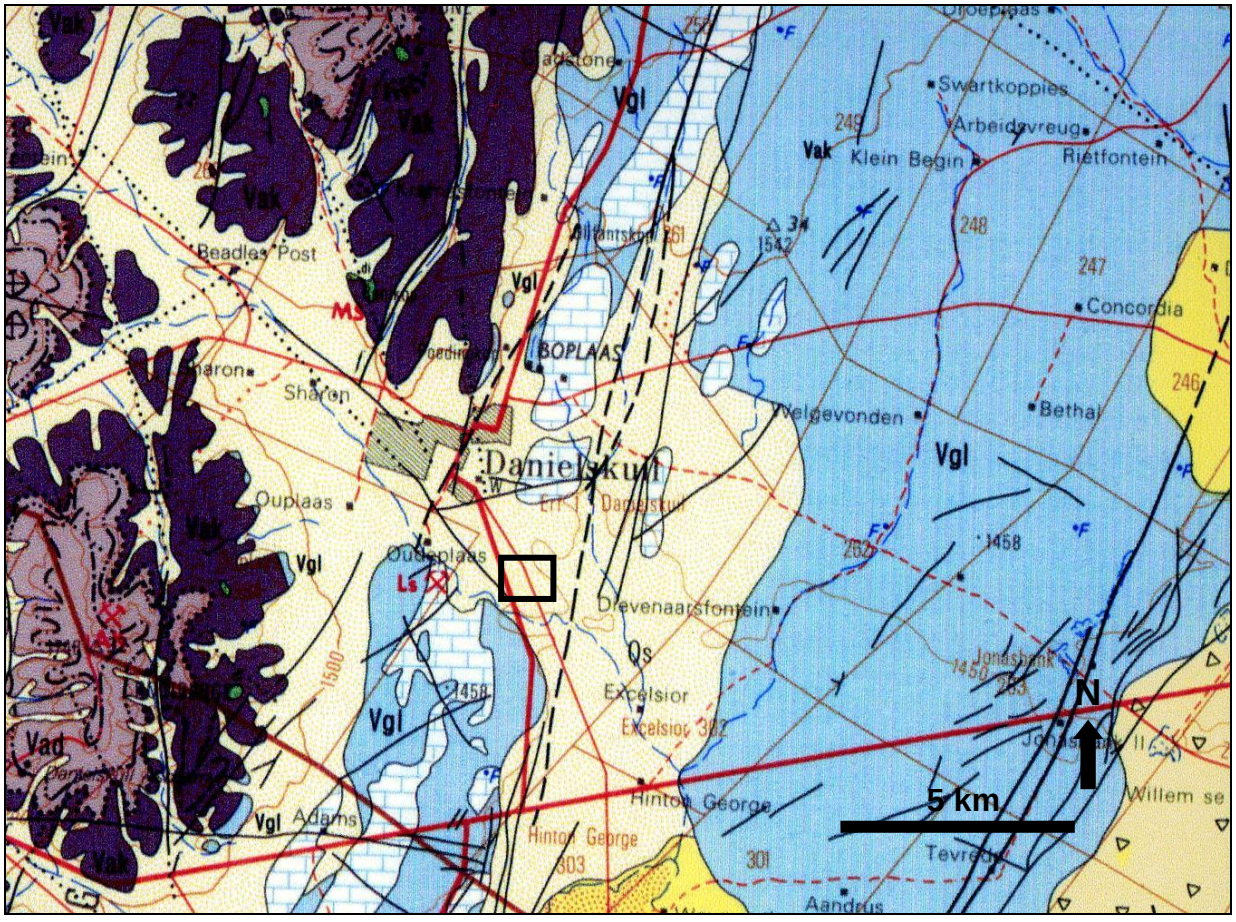

Fig. 1. Extract from 1: 250 000 geological map 2822 Postmasburg (Council for Geoscience, Pretoria) showing *approximate* location of proposed Daniëlskuil Roma Solar Plant study area on the south-eastern outskirts of Daniëlskuil, Northern Cape Province (small black rectangle). The study area is underlain at depth by Precambrian (Early Proterozoic) carbonate rocks of the Kogelbeen Formation, Campbell Rand Subgroup (Vgl) that are mantled here by a veneer of wind-blown sands (Qs, pale yellow) and other superficial deposits.

Fig. 2. Google earth© satellite image showing the flat-lying study area for the Daniëlskuil Roma Solar Plant on the south-eastern outskirts of Daniëlskuil, Northern Cape (yellow polygon). The area is mantled with wind-blown Kalahari sands with very limited bedrock exposure. The Idwala limestone mine is situated just to the west.

3.1. Cumulative impacts on palaeontological heritage

In order to assess cumulative impacts on palaeontological heritage, previous palaeontological impact assessment reports (PIAs) for alternative energy and other developments in the Daniëlskuil region were accessed using the SAHRIS website as well as the author's own database. It is noted that for the great majority of development proposals in the region a PIA report has not been submitted. Most of the proposals are for mine prospecting, but they also include railway, powerline and solar power developments. In practice, the only strictly relevant studies are those that deal with comparable fossil heritage assemblages from the same sedimentary rock units that are represented in the Daniëlskuil Roma solar plant itself, and in particular the stromatolite-bearing Kogelbeen Formation (Campbell Rand Subgroup) and Kalahari Group. PIAs reviewed include those for the Humansrus CSP development near Humansrus and its associated powerline to Lime Acres (Almond 2011a, Almond 2015), the Arriesfontein solar power plant and Olien Solar Project *c*. 25 km SE of Daniëlskuil (Almond 2011b, Botha-Brink 2012), the Eskom Ulco-Olien-Manganore transmission line (Bamford 2014), the Limestone 1 - 132kV Power Line and switchyard to the WE of Daniëlskuil (Fourie 2013) and the Transnet 16 MTPA manganese ore railway line upgrade, Hotazel to Kimberley (Almond 2013). In general, the anticipated impact significance of these developments on local fossil heritage was rated by the respective authors as low to very low. The only study that documents well-preserved stromatolites at surface in the region is that by Almond (2015), and the anticipated impacts here are of low significance. These stromatolites occur south of the R385 to the north of Lime Acres Mine (*c*. 7 km SW of the Daniëlskuil Roma solar plant study area), and important stromatolitic horizons are also exposed in the mine itself. It is quite likely that further stromatolitic beds are exposed and being impacted within the Idwala Limestone Mine just to the west of the present study area; to the author's knowledge, this possibility has not been investigated or documented, however. Clearly, the potential impacts on fossil heritage due to the existing mine far outweigh those posed by the small-scale Daniëlskuil Roma solar plant itself.

It is concluded that cumulative impacts on fossil stromatolite occurrences within the Campbell Rand Subgroup in the Daniëlskuil region are likely to be already moderately high due to the large-scale mining here. However, *additional* potential losses of fossil heritage posed by the construction of the Daniëlskuil Roma solar plant are unlikely to be significant. Current losses of Precambrian fossil heritage can be set against the probable widespread occurrence of stromatolitic beds in the subsurface of the extensive Ghaap Plateau (*i.e.* unique fossil heritage is not highly threatened). Furthermore, mining and other bedrock excavations may provide access for palaeontologists to previously inaccessible stromatolite beds. A premium should be set on the conservation of surface exposures of well-preserved stromatolites (such as seen *c*. 7 km SW of the Daniëlskuil Roma solar plant study area) since partial surface weathering usefully enhances many of the stromatolitic features for scientific study (*cf* Almond 2015).

4. CONCLUSIONS & RECOMMENDATIONS

Despite the known occurrence of stromatolites and other microbial fossils in Precambrian bedrocks underlying the study area, the impact significance of the proposed Daniëlskuil Roma solar plant development in terms of local fossil heritage resources is considered to be LOW because:

- The fossiliferous Precambrian bedrocks are largely mantled here by superficial sediments (*e.g.* wind-blown sands) of low palaeontological sensitivity. Good surface exposures of stromatolitic limestone are not present here;
- The stromatolites within the Campbell Rand Subgroup are of widespread occurrence, and can be far better studied or sampled in large quarries near Daniëlskuil and at Lime Acres, some 15 km to the SSW, or at surface *c*. 7 km to the SW;
- Extensive, deep excavations into bedrock are unlikely to be involved in this sort of solar park project.

It is therefore recommended that, pending the exposure of significant new fossils during development, exemption from further specialist palaeontological studies and mitigation be granted for this solar plant development.

There are no objections on palaeontological heritage grounds to authorisation of the proposed power plant. Should any substantial fossil remains (*e.g.* vertebrate bones and teeth, shells, calcretised burrows) be encountered during excavation, however, these should be reported to SAHRA for possible mitigation by a professional palaeontologist (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za).

The Environmental Control Officer (ECO) responsible for the solar plant development should be made aware of the potential occurrence of scientifically-important fossil remains such as stromatolites within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads) and deeper (> 1 m) excavations (*e.g.* for solar panel footings) should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains - such as stromatolites, vertebrate bones and teeth - be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management authority as soon as possible - *i.e.* SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). This is to ensure that appropriate action - *i.e.* recording, sampling or collection of fossils, recording of relevant geological data - can be taken by a professional palaeontologist at the developer's expense.

These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the solar plant project.

Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency (in this case Heritage Western Cape);

- The palaeontologist concerned with potential mitigation work will need a valid fossil collection permit from SAHRA (N. Cape) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection);

- All palaeontological specialist work should conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by HWC (2016) and SAHRA (2013).

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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, Gauteng, KwaZulu-Natal, Mpumalanga, Northwest and Free State 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 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**