PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

PROPOSED AGRICULTURAL DEVELOPMENT ON BOTHA FARM, PRIESKA, SIYATHEMBA MUNICIPALITY, NORTHERN CAPE

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EXECUTIVE SUMMARY

It is proposed to develop a 80 ha portion of land for new vineyards on Botha Farm, situated on the eastern outskirts of Prieska, Siyathemba Municipality, Northern Cape. The proposed agricultural development is underlain at depth by glacial / interglacial sediments of the Permo-Carboniferous Dwyka Group (Karoo Supergroup). These bedrocks are at most sparsely fossiliferous are unlikely to be significantly impacted by this sort of development that does not entail deep, voluminous excavations. The Dwyka bedrocks are overlain in the study area by a thick (several meters) mantle of Late Caenozoic superficial sediments including gravelly alluvial deposits of the Orange River and its tributaries, calcrete hardpans, downwasted surface gravels, and wind-blown sands. Older "High Level" alluvial gravels of Late Tertiary to Quaternary age are not mapped in this area. The only fossil remains recorded from calcretised alluvial sediments in previous field studies in the Prieska area comprise ubiquitous subfossil plant root casts that are not of critical conservation significance. It is concluded that the palaeontological heritage significance of the proposed agricultural development is LOW. Pending the discovery of significant new fossil material during construction, no further specialist palaeontological studies or mitigation are recommended here.

In the case of any substantial fossil finds during construction (*e.g.* vertebrate teeth, bones, burrows, petrified wood), these should be safeguarded - preferably *in situ* - and reported by the ECO as soon as possible to SAHRA so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented (Contact details: Ms Natasha Higgitt, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: nhiggitt@sahra.org.za).

These recommendations should be incorporated into the Environmental Management Plan (EMP) for this project.

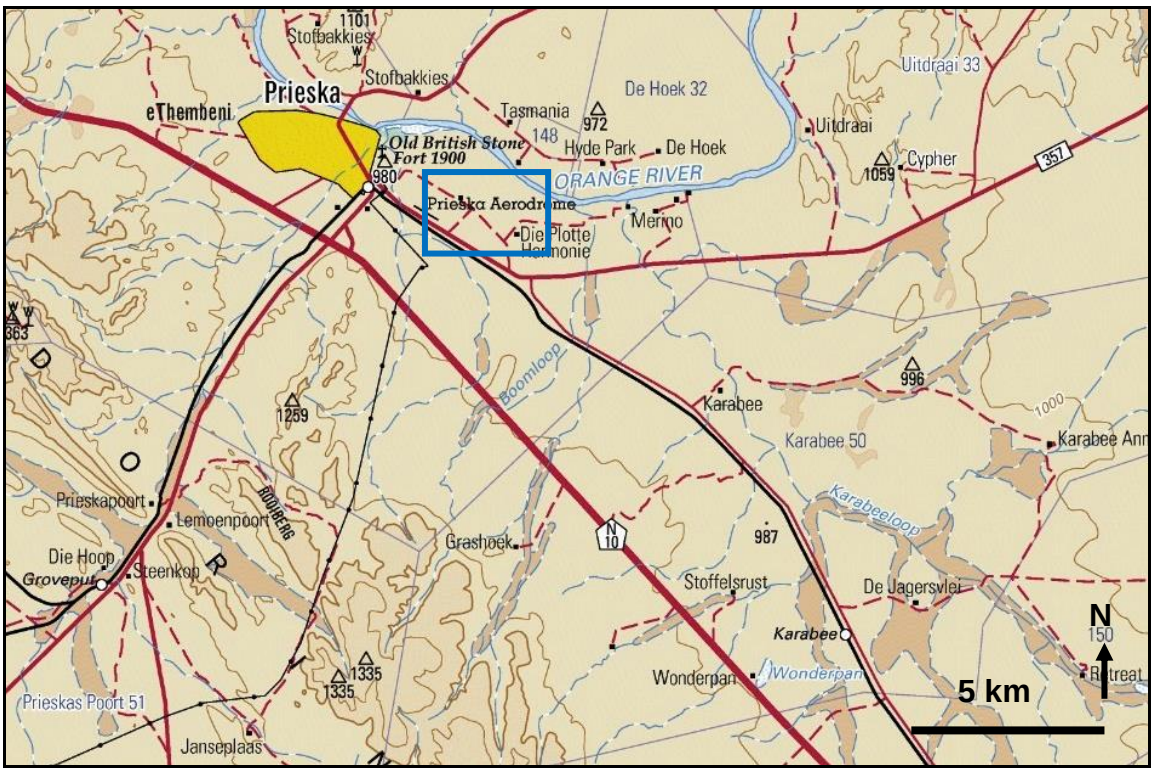

Figure 1. Extract from 1: 250 000 topographical sheet 2922 Prieska showing the approximate location of the proposed agricultural development on Botha Farm just east of Prieska, Siyathemba Municipality, Northern Cape (blue rectangle) (Map courtesy of The Chief Directorate, National Geospatial Information, Mowbray).

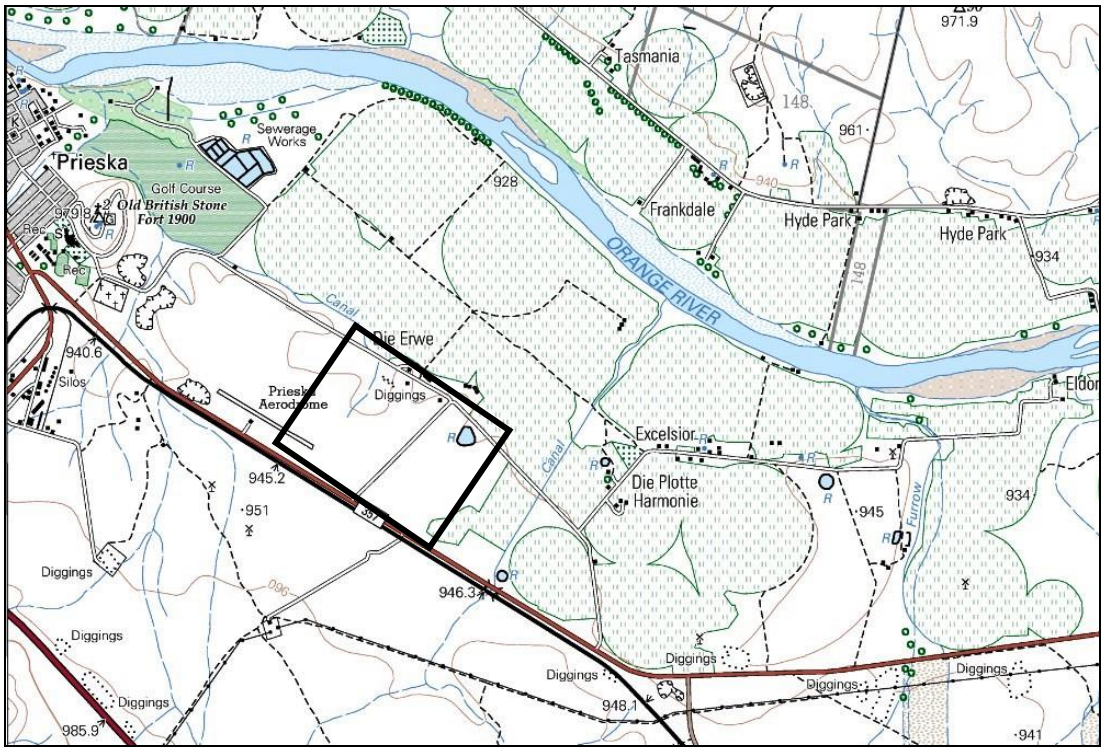

Figure 2. Abstract from 1: 50 000 topographical sheet 2922DB showing the approximate location of the agricultural project study area on Botha Farm (black rectangle), close to the old aerodrome on the eastern outskirts of Prieska (See Figure 4 for more accurate outline of the study area).

1. INTRODUCTION & BRIEF

It is proposed to develop a 80 ha portion of land for new vineyards on Botha Farm, situated on the eastern outskirts of Prieska, Siyathemba Municipality, Northern Cape. The site lies close to the old aerodrome to the north of the R357 Prieska to Douglas tar road and some 2 km southwest of the banks of the Orange River (Figs. 1 to 4).

The present palaeontological heritage desktop assessment of the development has been commissioned on behalf of the developer, Jan-Philip Botha, by Enviro Logic of Tyger Valley (Contact details: Mnr Gert Pretorius. Enviro Logic. PO Box 3731. Tyger Valley 7536. Tel/ Fax: (021) 919 4048. Cell: 082 458 9844. E-mail: gpec12@telkomsa.net).

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

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

Figure 3. Google earth© satellite image of the semi-arid terrain in the study region to the east of Prieska, Northern Cape (yellow polygon), showing traces of the old aerodrome, the general high level of surface disturbance as well as intensive irrigation agriculture to the north.

Figure 4. Outline of the study area (black polygon) for the proposed agricultural development (Image abstracted from the Irrigation Suitability report for Botha Farm produce by Digital Soils Africa, 2017).

1.1. Legislative Framework

The present palaeontological heritage assessment report contributes to the Heritage Impact Assessment for the proposed agricultural development 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 project.

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- 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).

1.2. General approach used for this palaeontological impact study

This PIA report provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations for specialist palaeontological mitigation where this is considered necessary. The report is based on (1) a review of the relevant scientific literature, (2) published geological maps and accompanying sheet explanations as well as (3) the author's extensive field experience with the formations concerned and their palaeontological heritage (*cf* Almond 2013a 2013b, 2013c).

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. 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 scoping 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 Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond & Pether 2008). 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 notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted.

On the basis of the desktop and any recommended field studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) – is usually most effective 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 a palaeontological collection permit from the relevant heritage management authority, SAHRA (Contact details: Ms Natasha Higgitt, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: nhiggitt@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.

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 Prieska in the Northern Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation. However, bedrock exposure is constrained by extensive superficial deposits, such as alluvium, surface gravels and soils, and there has been little formal palaeontological fieldwork in this area. Confidence levels for this impact assessment are nevertheless rated as *medium*.

2. GEOLOGICAL CONTEXT

The study area on Botha Farm near Prieska comprises semi-arid, fairly flat-lying terrain at elevations between *c*. 940 to 950 m amsl and situated some two kilometres southwest of the present banks of the Orange River. As seen on satellite images (Figs. 3 & 4), much of the study area, which is situated close to the old aerodrome, is disturbed while the lands between the site and the river have been transformed for irrigation agriculture. The 1: 50 000 map shows several borrow pits in the wider region, while diggings, a stream and a small dam occur within the study area itself (Fig. 3).The geology of the Prieska study region is outlined on the 1: 250 000 geological sheet 2922 Prieska, for which a sheet explanation has not yet been published (Council for Geoscience, Pretoria) (Fig. 5). A similar geological setting for a solar energy project area some 4 km to the southeast of the present study area has been described by Almond (2013b).

Beneath the superficial sediment cover Permo-Carboniferous glacial sediments of the **Dwyka Group** (**C-Pd, Karoo Supergroup**) underlie the entire Botha Farm study area. However Dwyka Group rocks would only be intersected by deep excavations (> several meters) during development. The geology of the Dwyka Group has been summarized by Visser (1989), Visser *et al.* (1990) and Johnson *et al.* (2006), among others, and is summarized for the Prieska region by Almond (2013b). According to maps in Visser *et al.* (1990) and Von Brunn and Visser (1999) the Dwyka rocks in the Prieska-Copperton area close to the northern edge of the Main Karoo Basin belong to the **Mbizane Formation**. This is equivalent to the Northern (valley and inlet) Facies of Visser *et al*. (1990). The Mbizane Formation, up to 190 m thick, is recognized across the entire northern margin of the Main Karoo Basin where it may variously form the whole or (as here) only the *upper* part of the Dwyka succession. It is characterized by its extremely heterolithic nature, with marked vertical and horizontal facies variation (Von Brunn & Visser 1999). The proportion of diamictite and mudrock is often low, the former often confined to basement depressions. Orange-tinted sandstones (often structureless or displaying extensive soft-sediment deformation, amalgamation and mass flow processes) may dominate the succession. The Mbizane-type heterolithic successions characterize the thicker Dwyka of the ancient palaeovalleys cutting back into the northern basement rocks.

Previous fieldwork in the region (*e.g.* Almond 2013b) as well as geological mapping indicate that the Dwyka Group bedrocks in the agricultural project study area are entirely mantled by a range of **superficial sediments** of Late Caenozoic age (On the geological map Fig. 5 exposed Dwyka rocks are indicated in grey, for example along the River Orange, while subsurface occurrences away from the river are shown in pale brown). These varied superficial sediments are probably of Quaternary to Recent age for the most part and may be several meters thick. They are not mapped in detail at 1: 250 000 scale. Superficial sediments mapped to the east of Prieska include:

- **alluvial deposits** of the Orange River as well as overlying **sandy soils** (Qs) (pale yellow in Fig. 5) – mapped between the study area and the Orange River, but now largely transformed by agriculture;

- **aeolian (wind-blown) sands** normally assigned to the Gordonia Formation of the Kalahari Group (Qg, pale yellow with stipple in Fig. 5) – mapped outside and just to the south of the study area;
- pedocretes (ancient cemented soils) such as **calcrete hardpans** (T-Qc, dark yellow in Fig. 5) – mapped across the great majority of the study area.

Ancient (Tertiary) **alluvial gravels** or "High Level Gravels" mantling river-cut pediment surfaces are not mapped within the present study area, although they might be present at depth, immediately overlying the Palaeozoic bedrocks. Exposures of these various superficial deposits have been described and illustrated for an area *c*. 4 km southeast of the present study area by Almond (2013b). Soil profiles illustrated in the technical report for Botha Farm by Digital Soils Africa (2017) show several meters of gravelly orange-brown alluvial soils with variable development of subsurface calcrete hardpans.

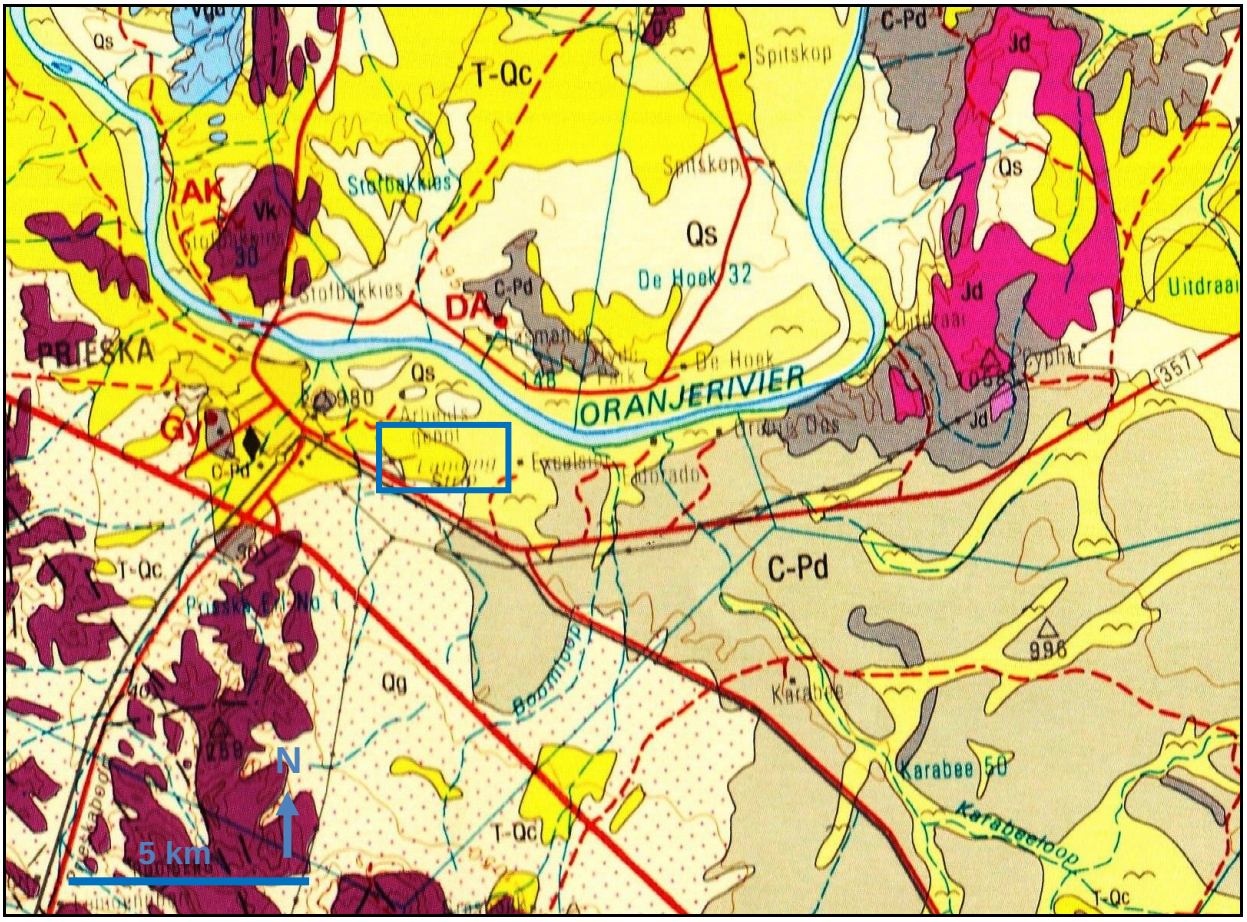

Figure 5. Extract from 1: 250 000 geology sheet 2922 Prieska (Council for Geoscience, Pretoria) showing approximate location of the proposed agricultural development close to the old aerodrome on Botha Farm, just east of Prieska, Northern Cape (blue rectangle). The study area is underlain at depth by Permo-Carboniferous glacial sediments of the Dwyka Group (C-Pd, pale brown) that are overlain by calcretised alluvial soils of the Orange River (T-Qc, yellow). Older "High Level Gravels" of the Orange River are not mapped in this area. Small patches of Late Caenozoic alluvial sediments to the north (pale yellow with "flying bird" symbol) have been modified by subsequent agricultural development. Aeolian sands (Qg, pae yellow with stipple) crop out just to the south of the area.

3. PALAEONTOLOGICAL HERITAGE

The Dwyka Group bedrocks are not exposed in the study area and are unlikely to be intersected by the proposed solar facility development. Their palaeontology will therefore not be considered further here.

3.1. Fossil heritage in the superficial deposits (Neogene – Recent)

The various superficial "drift deposits" of the Bushmanland and Karoo regions of South Africa, including aeolian sands, alluvium, calcretes and pan deposits, have been comparatively neglected in palaeontological terms. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises. Good examples are the Pleistocene mammal faunas at Florisbad, Cornelia and Erfkroon in the Free State and elsewhere (Wells & Cooke 1942, Cooke 1974, Skead 1980, Klein 1984, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000 Partridge & Scott 2000). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.* calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens, spores) in organic-rich alluvial horizons (Scott 2000) and siliceous diatoms in pan sediments. Calcrete hardpans might also contain trace fossils such as rhizoliths, termite nests and other insect burrows, or even mammalian trackways. Solution hollows within well-developed calcrete horizons may have acted as fossil traps in the past, as seen in Late Caenozoic limestones near the coast and Precambrian carbonate successions of the Southern African interior. Dense concentrations of vertebrate remains (*e.g.* small mammals, reptiles) or terrestrial molluscs, for example, are a possibility here. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.* Smith 1999 and refs. therein). Stone artefacts of Pleistocene and younger age may additionally prove useful in constraining the age of superficial deposits such as gravelly alluvium and pedocretes within which they are occasionally embedded.

Important fossil mammalian remains assigned to the Florisian Mammal Age (*c*. 300 000 – 12 000 BP; MacRae 1999) have recently been documented from stratigraphic units designated Group 4 to Group 6 (*i.e.* calcrete hardpan and below) at Bundu Pan, some 22 km northwest of Copperton (Kiberd 2006 and refs. therein). These are among very few Middle Pleistocene faunal records from stratified deposits in the southern Africa region (Klein 1980, 1984a, 1984b, 2000) and are therefore of high palaeontological significance. Characteristic extinct Pleistocene species recorded at Bundu Pan are the giant Cape Horse or Zebra (*Equus capensis*) and the Giant Hartebeest (*Megalotragus priscus*). Other extant to extinct taxa include species of warthog, blesbok, black wildebeest, springbok and baboon. There is additionally trace fossil evidence for hyaenids (tooth marks) as well as ostrich egg shell. Preliminary dating and the inferred ecology of the fossil taxa present suggests the presence of standing water within a grassy savanna setting during the 200-300 000 BP interval when the Bunda Pan faunal assemblage accumulated. A sequence of Earlier, Middle and Later Stone Age artefact assemblages is also recorded from this site. Stratigraphic Groups 4 to 6 (*i.e.* calcrete hardpan and below) contain a Final Acheulian or transitional ESA / MSA artefact assemblage, while Groups 2-3 above the calcrete horizon contain a MSA artefact assemblage.

Potentially fossiliferous older alluvial gravels that may be present at depth (several meters) along the contact of the Dwyka Group bedrocks and the superficial sediments are unlikely to be directly impacted by the proposed agricultural development. No fossil remains, with the exception of ill-defined subfossil plant root casts within calcretised alluvial sediments, were recorded within the superficial deposits to the southwest, southeast and northeast of Prieska by Almond (2013a, 2013b, 2013c respectively). Such trace fossils occur widely within Late Caenozoic calcretes of the Northern Cape and are not of critical conservation significance. It is concluded that the palaeontological sensitivity of the Botha Farm study area is LOW.

4. SUMMARY & RECOMMENDATIONS

The proposed agricultural development on Botha Farm near Prieska is underlain at depth by glacial / interglacial sediments of the Permo-Carboniferous Dwyka Group (Karoo Supergroup). These bedrocks are at most sparsely fossiliferous are unlikely to be significantly impacted by this sort of development that does not entail deep, voluminous excavations. The Dwyka bedrocks are overlain in the study area by a thick (several meters) mantle of Late Caenozoic superficial sediments including gravelly alluvial deposits of the Orange River and its tributaries, calcrete hardpans, downwasted surface gravels, and wind-blown sands. Older "High Level" alluvial gravels of Late Tertiary to Quaternary age are not mapped in this area. The only fossil remains recorded from calcretised alluvial sediments in previous field studies in the Prieska area comprise ubiquitous subfossil plant root casts that are not of critical conservation significance. It is concluded that the palaeontological heritage significance of the proposed agricultural development is LOW. Pending the discovery of significant new fossil material during construction, no further specialist palaeontological studies or mitigation are recommended here.

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These recommendations should be incorporated into the Environmental Management Plan (EMP) for this project.

5. ACKNOWLEDGEMENTS

Mnr Gert Pretorius of Enviro Logic, Tyger Valley, is thanked for commissioning this study and for providing the necessary background information. I am also grateful to Jonathan Kaplan of ACRM, Cape Town, for discussions on related heritage issues.

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7. 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.

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