RECOMMENDED EXEMPTION FROM FURTHER PALAEONTOLOGICAL STUDIES:

PROPOSED DEVELOPMENT OF TWO QUARRIES AND TWO BORROW PITS ON PORTION 1 OF FARM VOGELSTRUISBULT 104 NEAR COPPERTON, SIYATHEMBA MUNICIPALITY, NORTHERN CAPE

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1. OUTLINE OF THE PROPOSED DEVELOPMENTS

It is proposed to develop a series of two quarries and two borrow pits on Portion 1 of Farm Vogelstruisbult 104 in the vicinity of Copperton Village and the disused Copperton Mine, Siyathemba Municipality, Northern Cape. The locations of the four study sites are indicated on the relevant 1: 50 000 topographical map 2922CD and Google earth© satellite image in Figures 1 and 2 respectively.

The present palaeontological heritage assessment comments for the four proposed borrow pit and quarry developments have been commissioned by ASHA Consulting (Pty) Ltd (Contact details: Dr Jayson Orton, 6A Scarborough Road, Muizenberg, 7945. Tel: 021 788 8425. Cell: 083 272 3225. E-mail: jayson@asha-consulting.co.za). The report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the Environmental Management Plan for this 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;
- 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 recently been published by SAHRA (2013).

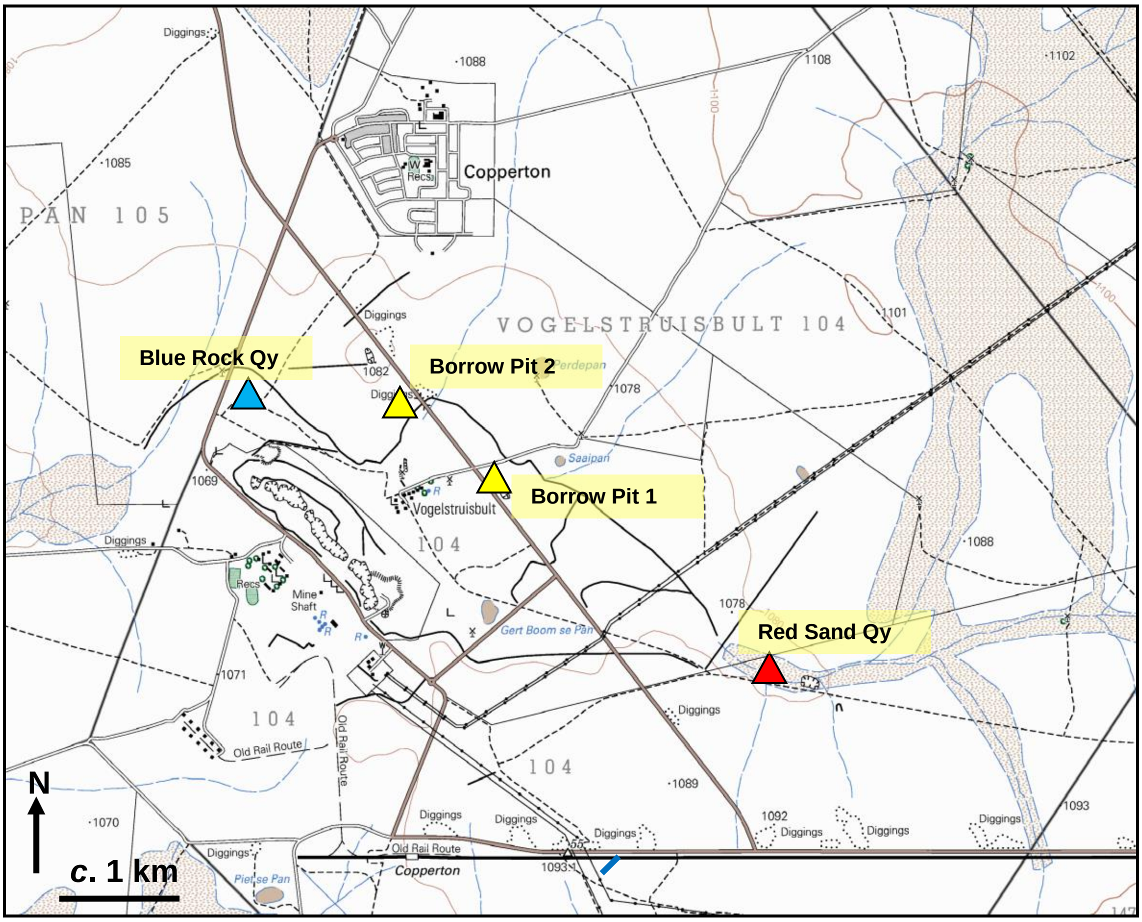

Figure 1: Extract from 1: 50 000 topographical sheet 2922CD (Courtesy of the Chief Directorate National Geo-spatial Information, Mowbray) showing the location of the two proposed borrow pit and two proposed quarry sites on Farm Vogelstruisbult 104 near Copperton (triangular symbols).

Figure 2: Google earth© satellite image of the study area to the south of Copperton village and around the outskirts of the currently disused Copperton mine, Northern Cape, showing the location of the two proposed quarries and borrow pits (white polygons).

2. GEOLOGICAL BACKGROUND

The geology of the study area around Copperton is shown on the 1: 250 000 geology map 2922 Prieska (Council for Geoscience, Pretoria; Fig. 3 herein). There is as yet no explanation published for the Prieska geology sheet but several of the various rock units mapped here are treated in some detail in the adjoining sheet explanations by Prinsloo (1989) and Slabbert *et al*. (1999).

The study area comprises flat-lying, semi-arid terrain at around 1070-1080 m amsl close to Copperton mining village and the defunct Copperton Mine (Figs. 1 & 2). Several recent palaeontological impact assessments in the Copperton area by the author have outlined the geology of the region (*e.g.* Almond 2012a, 2012b, 2013a, 2013b, 2014). As suggested by the 1: 250 000 geological map 2922 Prieska, the Copperton region is extensively underlain by Permo-Carboniferous glacial rocks of the **Dwyka Group** (**Karoo Supergroup**) (C-Pd in Fig. 3). However, within the study area itself the Karoo sediments are largely mantled by Quaternary aeolian sands of the **Gordonia Formation** (**Kalahari Group**).

Several small inliers of much older basement rocks emerge through the cover of Kalahari sands and other superficial deposits in the Copperton area. On the farm Vogelstruisbult 104 these Precambrian basement rocks are assigned in part to the **Vogelstruisbult Formation** of the **Jacobsmyn Pan Group** (Mv in Fig. 3), mainly consisting of high grade metamorphic rocks such as banded pelitic gneiss and migmatites. These highly metamorphosed rocks are generally of ill-defined Mokolian age (*i.e.* Mid Proterozoic, between 1000 and 2050 Ma) (Slabbert *et al.* 1999, Cornell *et al.* 2006) and were last metamorphosed some one billion or so years ago (1 – 1.2 Ga). Other basement inliers are referred to the **Spioenkop Formation** within the **Marydale Group** (Ms in Fig. 2). They consist mainly of metamorphosed sediments (quartzites, schists) with some metamorphosed igneous rocks as well (*e.g.* amphibolites). The Marydale Group rocks form part of a 2-8 km thick Archaean (Early Precambrian) greenstone belt (ancient oceanic crust) along the southwest margin of the ancient Kaapvaal continent and are over 2.5 billion years old (Prinsloo 1989, Potgieter & Botha 1982, Brandl *et al.*, 2006). Since these Precambrian basement rocks are entirely unfossiliferous they will not be considered further here.

The following account of Late Caenozoic superficial sediments near Copperton is taken from a previous palaeontological heritage study for an alternative energy project on Vogelstruisbult by Almond (2012c).

Unconsolidated aeolian sands attributed to the Pleistocene to Recent **Gordonia Formation** of the Kalahari Group are mapped over large areas of the Struisbult study area (Qg in Fig. 3). Their thickness in the study region is uncertain. The geology of the Late Cretaceous to Recent Kalahari Group 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, dated in part from enclosed Middle to Late Stone Age stone tools (Dingle et al., 1983, p. 291). Note that the recent extension of the Pliocene - Pleistocene boundary from 1.8Ma back to 2.588 Ma would place the Gordonia Formation entirely within the Pleistocene Epoch.

A number of older Kalahari formations underlie the young wind-blown surface sands in the main Kalahari depository to the north of the study area. However, at the latitude of Copperton (*c*. 30° S) Gordonia Formation sands less than 30 m thick are likely to be the main or perhaps only Kalahari sediments present (*cf* isopach map of the Kalahari Group, fig. 6 *in* Partridge *et al*., 2006). These unconsolidated sands are probably locally to extensively underlain by thin surface gravels equivalent to the **Obobogorop Formation**, formed from down-wasted (residual) or water-transported clasts weathered out of the Dwyka tillites, as well as by calcretes of Pleistocene age or younger (*cf* **Mokalanen Formation**).

A well-developed massive and vuggy to laminated **calcrete hardpan** underlies the soil horizons over large parts of the Copperton study region, as well seen in quarry excavations along the R357 (Almond 2012a, 2012b). Extensive calcrete development is typical of the Ecca and Dwyka outcrop areas in Bushmanland, especially around pans (Prinsloo 1989). A horizon of poorly-sorted downwasted gravels usually occurs on the upper surface, beneath the superficial soil capping, and coarse gravels are often embedded within the calcrete hardpan. There have clearly been several phases of Late Caenozoic calcrete development in the region. Reworking of older calcretes into younger horizons is shown by lenticles of calcrete breccia and even well-developed conglomerates up to 2 m thick composed of well-rounded pebbly and cobbly calcrete clasts. Sizeable solution hollows (*dolines* or *makondos*) have not been reported, but may be present. Calcretisation extends several meters down as a network of veins into the underlying, deeply-weathered Dwyka mudrock saprolite (*in situ* weathered bedrock). These calcretes and overlying gravels may be tentatively equated with the Pleistocene Mokalanen and Obogorop Formations respectively of the Kalahari Group to the north.

A variety of gravelly, sandy and silty **alluvial sediments** line shallow, intermittently-flowing water courses, while pan areas typically contain fine-grained silts and calcrete-rich subsoils (*cf* Partridge & Scott 2000, Partridge *et al.* 2006). In areas of sparse vegetation where the soil surface has been ablated by wind and / or sheetwash processes, extensive sheets of sparse gravels clasts are present. Many of these are too large to have been moved by sheetwash processes, and must have downwasted more or less *in situ* as the Dwyka outcrop was denuded by erosion.

The detailed description of the superficial sediment stratigraphy at Bundu Pan, located only some 22 km northwest of Copperton, by Kiberd (2006 and refs. therein) is very relevant to the present study area. Seven stratigraphic units (Groups 1-7), some of them fossiliferous, were recognised in trenches into the pan area. Among these, the uppermost four units bear close comparison with deposits observed within borrow pits in the Copperton study area. These are, in ascending order, Group 4 (laminated to massive calcrete hardpan, locally silcretised), Group 3 (pebbly and cobbly gravels, locally calcretised), Group 2 (sands / silts with horizons of gravels) and Group 1 (reddish surface sands).

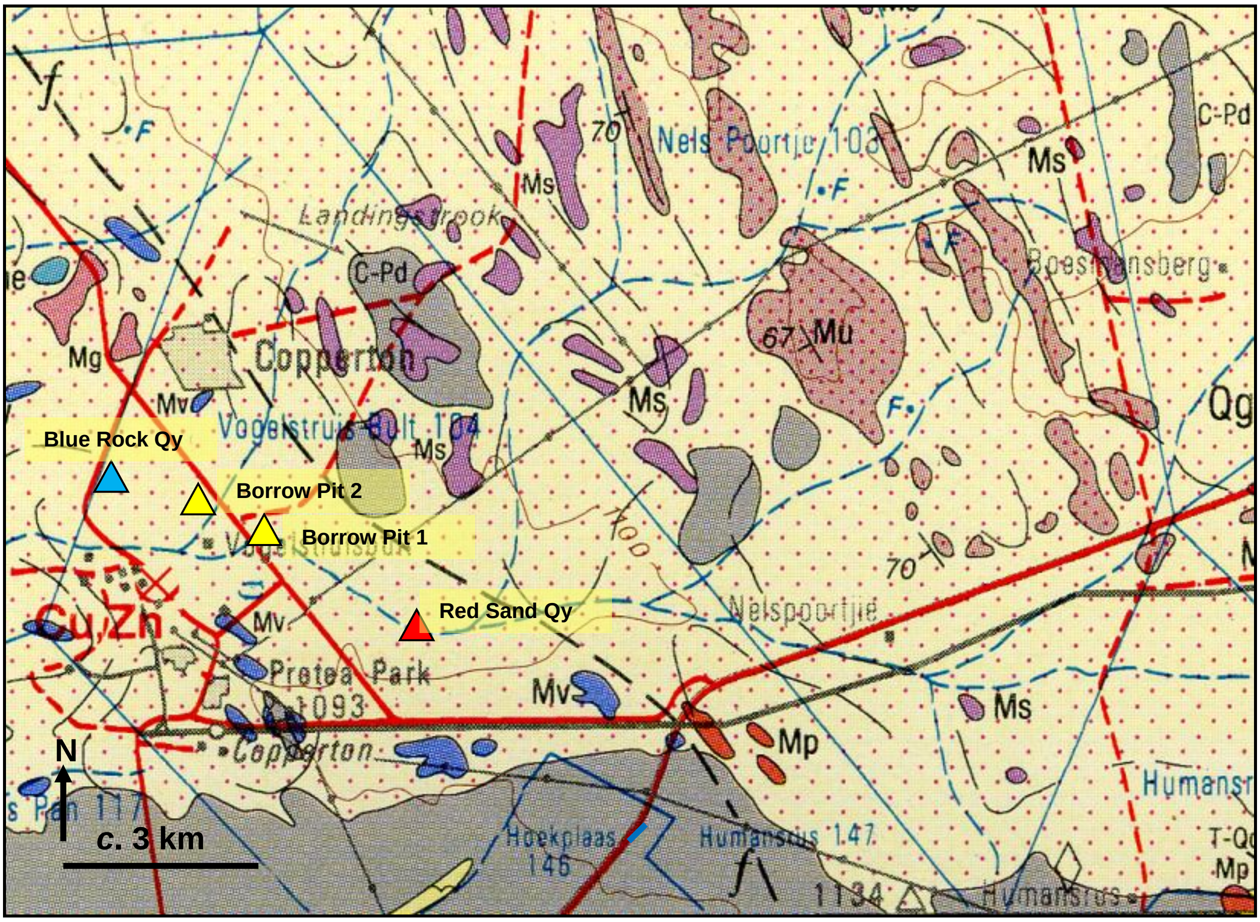

Figure 3: Extract from the 1: 250 000 geology map 2922 Prieska (Council for Geoscience, Pretoria) showing the approximate location of the four proposed borrow pit and quarry study areas on the farm Vogelstruisbult 104 near Copperton (triangular symbols).

The main geological units mapped within the broader study region are:
1. Precambrian (Mid Proterozoic / Mokolian) basement rocks (igneous / metamorphic):
Dark blue (Mv) = Vogelstruisbult Formation schists and gneisses (Jacobsmyn Pan Group)
Purple (Ms) = Spioenkop Formation quartzites, schists and gneisses (Marydale Group)
2. Late Carboniferous / Early Permian Karoo Supergroup sediments:
Grey (C-Pd) = Mbizane Formation (Dwyka Group)
3. Late Caenozoic (Quaternary to Recent) superficial deposits:
Pale yellow with dots (Qg) = reddish aeolian sands of Gordonia Formation (Kalahari Group)

- **Blue Rock Quarry**

The proposed open cast hard rock quarry site is situated in flat-lying terrain at *c.* 1070 m amsl. to the north of the disused Copperton Mine and *c*. 2 km southwest of Copperton Village (~ 29º 56' 25" S, 22º 17' 28" E). An existing bedrock excavation is situated in the north-western portion of the study area.

The relevant 1: 250 000 geological map (sheet 2922 Prieska) indicated that the gneisses underlying this area probably belong to the **Vogelstruisbult Formation** of the **Jacobsmyn Pan Group** (Figure 3). According to the EMP (EnviroSci Africa, 2014):

> The site is gneiss mother rock. The surface soils of the site consist of red-yellow apedal, freely drained soils with a high base status with low clay content. The surface is characterized by alluvial material, calcrete nodules and red sands from the Kalahari Group. The soil surface is scattered with pebbles and small boulders. The application is for a low volume hard rock (gneiss) open cast mining operation supplying material to the wind and photovoltaic energy facilities. The activities will be a blast and crushing operation.

- **Red Sand Quarry**

The proposed open case mine for sand and gravel is situated at *c*. 1080 m amsl. and about 2 km southeast of Copperton Village (~ 29º 57' 37" S, 22º 20' 11" E) . The site lies within the course of a broadly west-east trending watercourse that is clearly picked out by reddish sandy alluvium on satellite images (Figure 2). An existing borrow pit is located just to the east.

The 1: 250 000 geology sheet indicates that the site is mantled by Quaternary to Recent aeolian sands of the **Gordonia Formation** (Kalahari Group) (Fig. 3). According to the EMP (EnviroSci Africa, 2014):

> The site is underlayed by non-descript sedimentary parent material. There are no tillite outcroppings. The soils of the site consist of red-yellow apedal, freely drained soils with a high base status with low clay content. The surface is characterized by alluvial material, calcrete and red sands from the Kalahari Group. The soil surface is scattered with pebbles and small boulders. The application is for a low volume sand and gravel mining operation supplying material to the wind and photovoltaic energy facilities. The activities will be a simple load and haul operation.

- **Borrow Pits 1 & 2**

The two proposed new borrow pits will involve open cast mining for calcrete gravel. They are both located in flat-lying terrain at *c*. 1080 m amsl. in areas that are probably related to ancient water courses, as suggested by reddish hues (sandy alluvium) on satellite images (Fig. 2). Borrow Pit 1 is situated *c*. 2.7 km southeast of Copperton Village (~ 29º 56' 47" S, 22º 18' 47" E) and just east of a pre-existing borrow pit. Borrow Pit 2 lies *c*. 1.8 km south of Copperton Village (~ 29º 56' 24" S, 22º 18' 11" E) and just west of a pre-existing borrow pit.

The 1: 250 000 geology sheet indicates that both sites are mantled by Quaternary to Recent aeolian sands of the **Gordonia Formation** (Kalahari Group) (Fig. 3). According to the EMPs (EnviroSci Africa, 2014) in both cases:

> The site is underlayed by non-descript sedimentary parent material. There are no tillite outcroppings. Below surface a substantial calcrete layer is in evidence. The surface soils of the site consist of red-yellow apedal, freely drained soils with a high base status with low clay content. The surface is characterized by alluvial material, calcrete and red sands from the Kalahari Group. The soil surface is scattered with pebbles and small boulders.

3. PALAEONTOLOGICAL HERITAGE

The fossil heritage associated with each of the rock units represented in the Copperton study region has been previously outlined by Almond (2012c, 2013a, 2013b, 2014 and earlier references).

The Precambrian igneous and metamorphic **basement rocks** are entirely unfossiliferous and will not be considered further here. **Dwyka Group** sediments are unlikely to be directly impacted by the proposed mining activities and are in any case of low palaeontological sensitivity in the Copperton area (Almond 2012a, 2012b, 2013a, 2013b).

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 *in* Macey *et al.* 2011, 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 trace fossils such as rhizoliths, termite and other insect burrows, or even mammalian trackways.

Mammalian bones, teeth and horn cores (also tortoise remains, and fish, amphibian or even crocodiles in wetter depositional settings such as pans) may be expected occasionally expected within Kalahari Group sediments and calcretes, notably those associated with ancient, Plio-Pleistocene alluvial gravels. 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). Orton (2012) recently recorded a single fossil equid tooth associated with a rich MSA artefact assemblage exposed in an erosion donga leading into the southern edge of a small quarry on the farm Hoekplaas (originally a pan area), just to the southeast of the present study area. The tooth may have originally eroded out of a thin, MSA artefact-rich gravel horizon (palaoesurface) within soils exposed in section at the southern end of the gully. This horizon is probably equivalent to Group 2 of Kiberd's stratigraphy at Bundu Pan, and therefore somewhat younger than the Florisian mammal fauna reported there. However, since the erosion gully where the tooth was collected also incises older, coarser fluvial gravels that directly overlie the calcrete hardpan here, the source may in fact be equivalent to the slightly older Group 3 of Kiberd's scheme (Almond 2013a). It is quite likely that fossil bones and teeth of mammals are preserved within buried Pleistocene fluvial and pan sediments within the Vogelstruisbult Farm study area, as seen at Bundu Pan in the same region. However, such fossil sites are likely to be sparsely distributed and their locations difficult to predict, given the extensive younger sedimentary cover.

4. CONCLUSIONS & RECOMMENDATIONS

The Precambrian igneous and metamorphic basement rocks underlying the Vogelstruisbult 104 study area (**Blue Rock Quarry site**) at depth are entirely unfossiliferous. The overlying Permo-Carboniferous glacially-related sediments of the Dwyka Group (Karoo Supergroup) are, at most, sparsely fossiliferous, with occasional transported stromatolitic carbonate erratics. However, these Karoo sediments are unlikely to be directly impacted by the proposed shallow borrow pit and quarry developments. The Kalahari Group sediments (calcretes, alluvium and aeolian sands) mantling the older bedrocks that will be exploited in the **Red Sand Quarry site** as well as **Borrow Pits 1 and 2 sites** are generally of low palaeontological sensitivity. Quaternary fossil mammal bones and teeth have been recorded from similar rocks elsewhere in Bushmanland but are very scarce. They are most likely to be found in association with subsurface alluvial gravels and perhaps also stone artefacts concentrated along ancient water courses (Red Sand Quarry Site). It is concluded that the four proposed quarry and borrow pit developments near Copperton are unlikely to have significant impacts on local palaeontological heritage resources.

It is therefore recommended that, pending the discovery of significant new fossils remains before or during excavation, exemption from further specialist palaeontological studies be granted for the proposed Blue Rock Quarry, Red Sand Quarry, Borrow Pit 1 and Borrow Pit 2 developments on Portion 1 of Farm Vogelstruisbult 104 near Copperton.

Should any substantial fossil remains (*e.g.* well-preserved stromatolites, mammalian bones and teeth) be encountered during excavation, 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: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@sahra.org.za) 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.

5. ACKNOWLEDGEMENTS

Dr Jayson Orton of ASHA Consulting (Pty) Ltd is thanked for commissioning this study and for providing background documentation, including informative field photographs of the various quarry and borrow pit sites near Copperton.

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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 under the aegis of his Cape Town-based company *Natura Viva* cc. He is 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
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