

PALAEONTOLOGICAL SPECIALIST ASSESSMENT: DESKTOP STUDY

Proposed Plan 8 wind energy facility near Copperton, Northern Cape Province

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1. EXECUTIVE SUMMARY

The 200 MW phased wind energy facility proposed by the company Plan 8 (Pty) Ltd near Copperton involves erecting up to 90 wind turbines on Portions 4 and 7 of Farm Nelspoortje ("Struisbult") some 50 km southwest of Prieska, Northern Cape Province. The study area is largely covered by aeolian sands of the Kalahari Group (Quaternary to Recent Gordonia Formation). Permocarboniferous glacially-related rocks of the Dwyka Group (Mbizane Formation) may be present locally in the subsurface. Several rocky inliers of metamorphic rocks assigned to the Proterozoic (Late Precambrian) Uitdraai Formation (Brulpan Group) and the Archaean (Early Precambrian) Spioenkop Formation (Marydale Group) also crop out in the area.

The palaeontological sensitivity of all these rock units ranges from zero to low. Impacts on fossil heritage are only likely during the construction phase, if at all. Their scale would be local and their magnitude would be low. The impact significance of the proposed wind energy development as far as fossil heritage is concerned is therefore considered to be LOW and further specialist palaeontological studies or mitigation of this project are not considered necessary.

Should substantial fossil remains be exposed during construction, however, these should be safeguarded by the ECO, preferably *in situ*, and SAHRA should be notified by the ECO so that appropriate mitigation can be undertaken.

2. INTRODUCTION & BRIEF

The company Plan 8 (Pty) Ltd are planning to develop a phased wind energy facility of approximately 200 MW capacity on Nelspoortje Farm (Farm 103, Portions 4 and 7) near Copperton, Northern Cape Province (Figs. 1, 2). The study area of c. 3000 hectares lies about 5 km east of Copperton and 50 km southwest of the town of Prieska. The dust road between Prieska and Vanwyksvlei as well as the Copperton – Prieska railway lie just to the south.

The Copperton wind energy facility (DEA REF. NO. 12/12/20/2099) would be built over several years in three phases of approximately 20 (Phase 1), 20 (Phase 2) and 50 (Phase 3) wind turbines. Each turbine would be mounted on reinforced concrete foundations (approximately 20 m x 20 m) and be associated with a hard standing area (c. 20 m x 6 m). Other key components of the facility include internal gravel roads and a possible 6.5 km 132 kV transmission line to the Cuprum electricity substation at Copperton mine (Alternatively, only an existing 2 km connection to the transmission network adjacent to the farm would be utilised; see Fig. 1).

Aurecon South Africa (Pty) Ltd has been appointed to undertake the requisite environmental process as required in terms of the National Environmental Management Act (No. 107 of 1998), as

amended, on behalf of Plan 8. A desktop palaeontological assessment for the project has been commissioned by Aurecon in accordance with the requirements of the National Heritage Resources Act, 1999. The terms of reference for this study as defined by Aurecon are to undertake a desktop Paleontological Impact assessment of the site in accordance with the requirements of Section 38(3) of the NHRA which would include:

- Conducting a detailed desk-top level investigation to identify all palaeontology in the proposed development areas;
- Assessing the potential impacts of the proposed project and alternatives, including:
 - Assess the sensitivity and significance of palaeontology at the site;
 - Evaluation of the potential impacts of construction, operation and maintenance of the proposed development on palaeontological resources, in terms of the scale of impact (local, regional, national), magnitude of impact (low, medium or high) and the duration of the impact (construction, up to 10 years after construction (medium term), more than 10 years after construction (long term); and
 - Recommendation of mitigation measures to ameliorate any negative impacts on areas of paleontological importance.

This report is largely based on several previous palaeontological desktop studies by the author in the Copperton area, notably Almond (2010).



Fig. 1. Google Earth® satellite image of the study region showing the location (green polygon) of the proposed Plan 8 wind energy facility some 50 km southwest of the town of Prieska on the River Orange (top right). A 132 kV electricity connection already exists on site (right hand green marker), but a 6.5 km transmission line to the Cuprum Substation at Copperton is also under consideration (blue line).

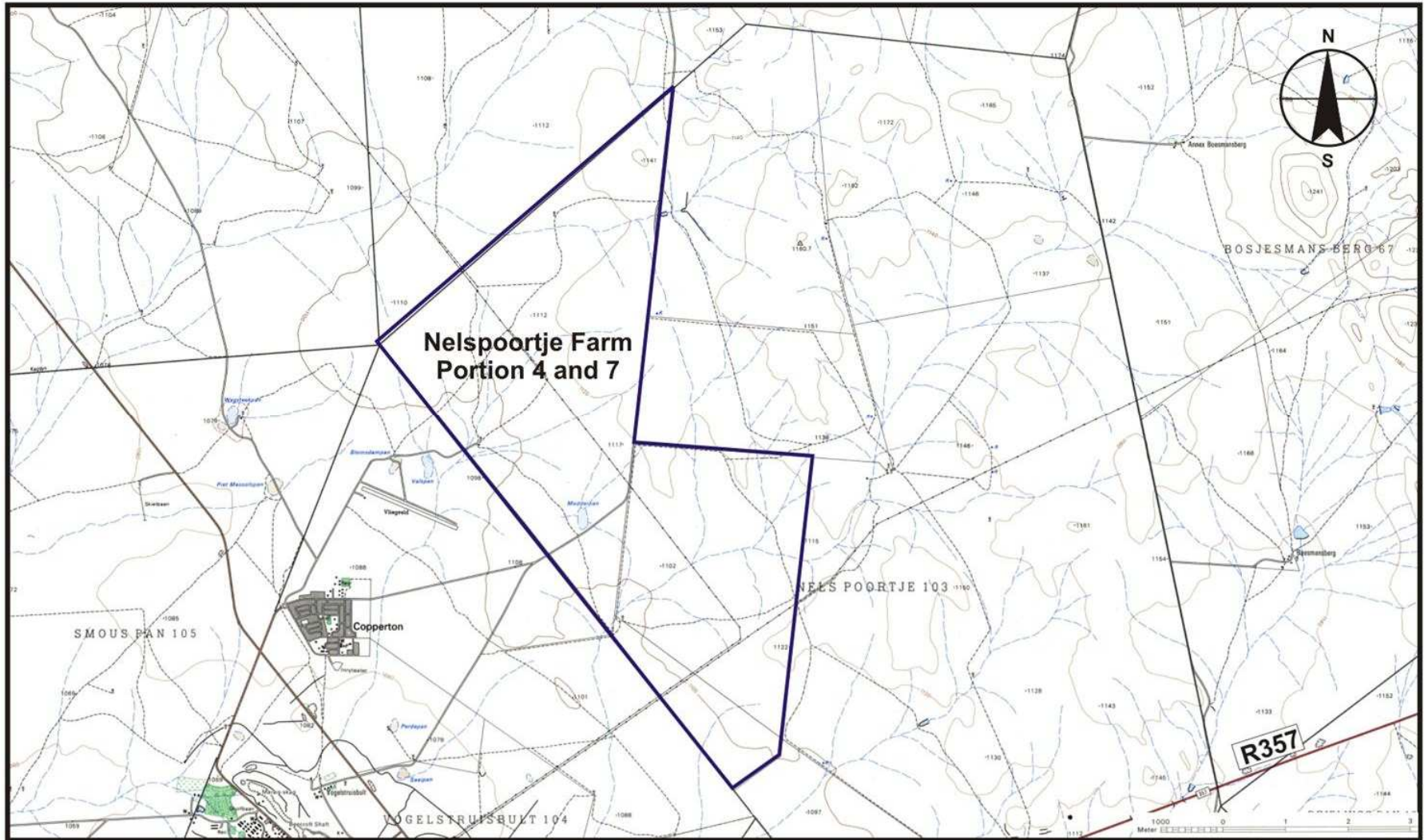


Fig. 2. Outline of the study area (black polygon) for the proposed Plan 8 wind energy facility on Nelspoortje Farm No 103, Portions 4 and 7, some 5km northeast of Copperton, Northern Cape (Map kindly provided by Aurecon).

3. GEOLOGICAL BACKGROUND

Satellite images of the Copperton study area (Fig. 1) show that the Plan 8 wind farm study area largely comprises fairly flat-lying, arid, sandy terrain lying at c. 1100 m amsl with several low *koppies* and rocky ridges. This region forms part of the low-relief *Kaiingveld* of eastern Bushmanland. Drainage is limited to small, intermittently active streams and pans. There is a net flow towards the west into old Tertiary drainage systems rather than the Orange River to the north. Vegetation cover is very low.

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). The explanation for the Prieska geological map has not yet been published; however, several of the rock units are treated in detail in the explanation for the Britstown sheet to the south (Prinsloo, 1989).

3.1. Late Caenozoic superficial sediments

The site of the proposed wind energy facility is largely underlain near-surface by unconsolidated aeolian (*i.e.* wind-blown) sands of the Quaternary **Gordonia Formation (Kalahari Group) (Qg** in Fig. 3) whose 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 (Fig. 4). However, at the latitude of Copperton (c. 30° S) Gordonia Formation sands less than 30m 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 might be locally 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, Fig. 4). Other unconsolidated superficial sediments of probable Quaternary to Recent age within the study area include sandy to gravelly stream alluvium as well as localized, finer-grained pan deposits (*e.g.* Modderpan).

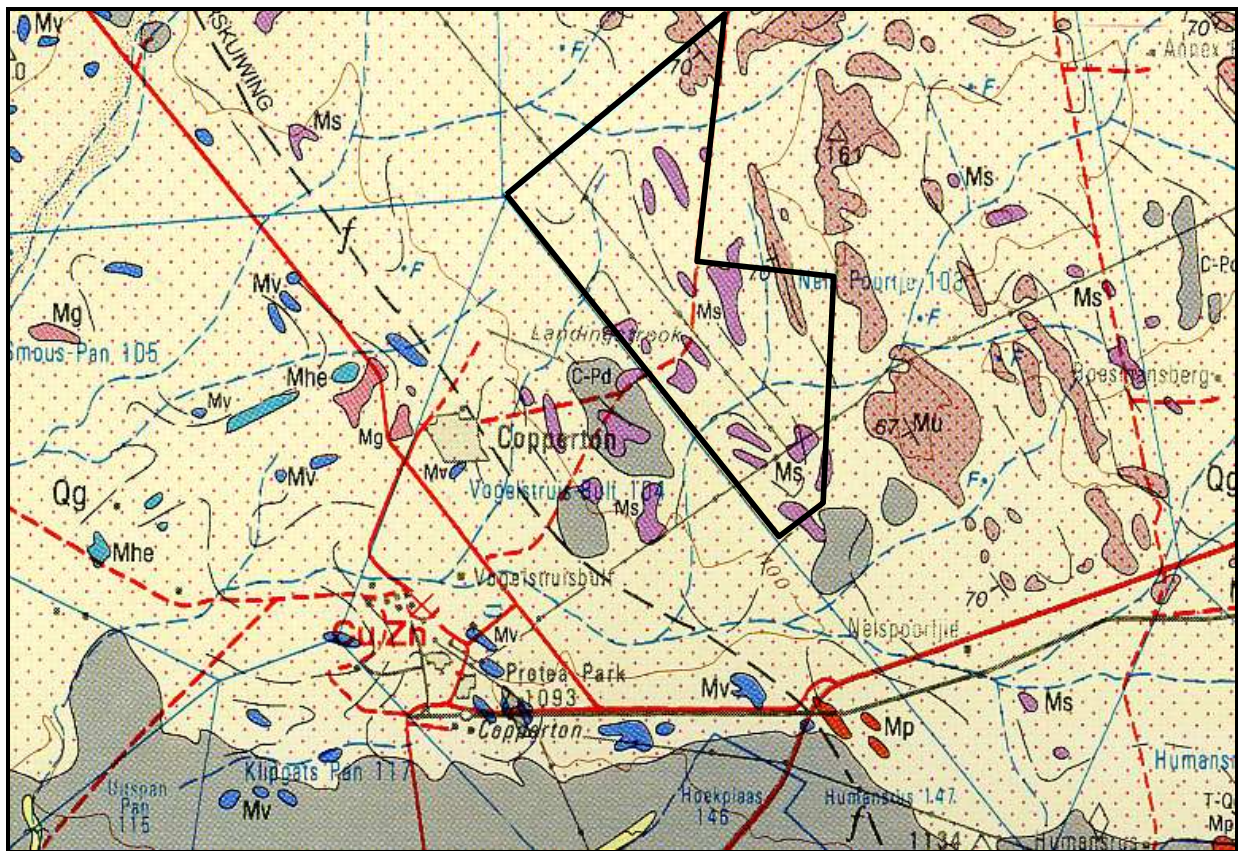


Fig. 3. Extract from 1: 250 000 geology map 2922 Prieska (Council for Geoscience, Pretoria) showing approximate outline of the proposed Plan 8 wind energy facility near Copperton (black polygon).

The main geological units mapped within the Copperton region are:

1. Precambrian basement rocks (igneous / metamorphic):

Reddish-brown with dots (Mu) = Uitdraai Formation (Brulpan Group)

Purple (Ms) = Spioenkop Formation (Marydale Group)

Dark blue (Mv) = Vogelstruisbult Formation (Jacobsmyl Pan Group)

2. Karoo Supergroup sediments:

Grey (C-Pd) = Mbizane Formation (Dwyka Group)

3. Late Caenozoic (Quaternary to Recent) superficial deposits:

Pale yellow (Qg) = Gordonia Formation (Kalahari Group)

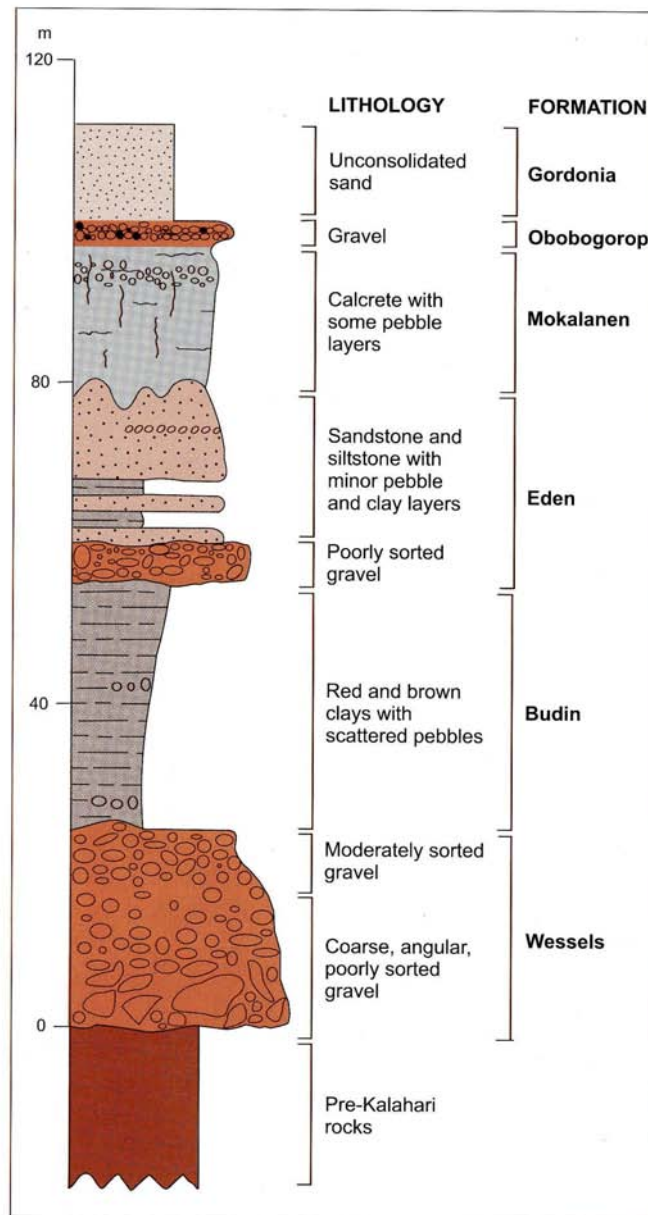


Fig. 4. Stratigraphy of the Kalahari Group (From Partridge *et al.*, 2006). Aeolian sands of the Gordonia Formation are represented in the study area.

3.2. Permocarboniferous Dwyka Group

Permocarboniferous glacial sediments of **Dwyka Group (C-Pd, Karoo Supergroup)** probably underlie the thin, superficial cover of Gordonia sands in parts of the study area. Dwyka rocks may therefore be intersected by deeper excavations 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.

The Dwyka Group along the north-western margin of the Main Karoo Basin in particular has been reviewed by Visser (1985). In Dwyka times the Prieska – Copperton area lay within a basement high region between the Sout River Valley in the west and the Prieska Basin in the east. This area is referred to as the Kaiing Hills or Kaiing Veld Region by Visser and is characterized by a relatively thin Dwyka succession (normally < 50m). This mainly comprises massive clast-rich diamictites and clast-poor argillaceous diamictites (“boulder shale”) overlain by a thin zone of laminated dropstone

argillite with outsized clasts composed mainly of quartzite and gneiss (Visser 1985). Note the presence of an isolated peak (monadnock) of Proterozoic basement rocks to the southeast of Copperton (*ibid.*). Ice transport directions initially towards the south and later towards the southwest are reconstructed by Visser (1985, his fig. 17).

More detailed observations by Prinsloo (1989) on the Dwyka beds on the northern edge of the Britstown 1: 250 000 sheet are relevant to the Copperton area just to the north. Good surface outcrops of the Dwyka beds are rare here due to extensive cover by thin surface gravels. Massive tillites at the base of the Dwyka succession were deposited by dry-based ice sheets in deeper basement valleys. Later climatic amelioration led to melting, marine transgression and the retreat of the icesheets onto the continental highlands in the north. The valleys were then occupied by marine inlets within which drifting glaciers deposited dropstones onto the muddy sea bed ("boulder shales"). The upper Dwyka beds are typically heterolithic, with shales, siltstones and fine-grained sandstones of deltaic and / or turbiditic origin. These upper successions are typically upwards-coarsening and show extensive soft-sediment deformation (loading and slumping). Varved (rhythmically laminated) mudrocks with gritty to fine gravelly dropstones indicate the onset of highly seasonal climates, with warmer intervals leading occasionally even to limestone precipitation.

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 190m 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.

3.3. Precambrian basement rocks

Numerous small inliers of ancient **Precambrian basement rocks** emerge through the cover of Kalahari sands in the Copperton area. Those to the southwest of the NW-SE fault line running past Copperton, west of the Plan 8 study area, are assigned to the **Vogelstruisbult Formation** of the **Jacobsmyn Pan Group (Mv)**. This group of basement rocks mainly consists of high grade metamorphic rocks (banded pelitic gneiss, migmatites) that are unfossiliferous (Slabbert *et al.*, 1999, Cornell *et al.*, 2006). They are of undetermined Mokolian age, *i.e.* mid-Proterozoic (between 1000 to 2050 Ma = million years old). An isolated remnant of Mokolian basement rocks was protected from pre-Dwyka erosion to the southeast of Copperton (Visser 1985). Metasedimentary basement rocks to the northeast of the fault line, within the Plan 8 study area, are assigned to the **Spioenkop Formation** of the **Marydale Group (Ms)** and the **Uitdraai Formation** of the **Brulpan Group (Mu)**. They consist mainly of metamorphosed sediments (quartzites, schists) with some metamorphosed igneous rocks as well (*e.g.* amphibolites). The former form part of a 2-8km 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, while the latter form part of the *circa* one billion year old Namaqua-Natal Province (Prinsloo 1989, Potgieter & Botha 1982, Brandl *et al.*, 2006, Cornell *et al.* 2006).

4. PALAEOLOGICAL HERITAGE

The fossil heritage recorded within each of the three rock units mapped at surface within the study area, as well as the Dwyka Group sediments that probably lie at shallow depths beneath the Kalahari sands here, is outlined here in order of increasing geological age (See also summary of fossil heritage in Table 1 below).

4.1. Fossils in the superficial sediments

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 Dwyka Group 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 (stonework 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 (Du Toit 1954, Dingle *et al.*, 1983). 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 (*ibid.*). Underlying calcretes 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) may be expected occasionally expected within Kalahari Group sediments. However, no fossil records of Pleistocene mammals are listed in the study region in the review by Klein (1984).

The other “drift deposits” of the Karoo and Bushmanland regions of South Africa, including alluvium 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. 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.

4.2. Fossils in the Dwyka Group

The generally poor fossil record of the Dwyka Group (McLachlan & Anderson 1973, Anderson & McLachlan 1976, Visser 1989, Visser *et al.*, 1990, Visser 2003, Almond & Pether 2008) is hardly surprising given the glacial climates that prevailed during much of the Late Carboniferous to Permian Periods in southern Africa. However, most Dwyka sediments were deposited during periods of glacial retreat associated with climatic amelioration. Sparse, low diversity fossil biotas from the Mbizane Formation in particular mainly consist of arthropod trackways associated with dropstone laminites and sporadic vascular plant remains, while palynomorphs (organic-walled microfossils) are also likely to be present within finer-grained mudrock facies. Glacial diamictites

(tillites or “boulder mudstones”) are normally unfossiliferous but do occasionally contain fragmentary transported plant material as well as palynomorphs in the fine-grained matrix. There are interesting records of limestone glacial erratics from tillites along the southern margins of the Great Karoo (Elandsvlei Formation) that contain Cambrian eodiscid trilobites as well as archaeocyathid sponges. Such derived fossils provide important data for reconstructing the movement of Gondwana ice sheets (Cooper & Oosthuizen 1974, Stone & Thompson 2005).

A limited range of marine fossils are associated with the later phases of several of the four main Dwyka deglaciation cycles (DSI to DSIV), especially in the Kalahari Basin of southern Namibia but also in some cases within the Main Karoo Basin in South Africa (Oelofsen 1986, Visser 1989, 1997, Visser *et al.* 1997, Bangert *et al.* 1999, Stollhofen *et al.* 2000, Almond 2008). These deglaciation sequences are estimated to have lasted five to seven million years on average (Bangert *et al.* 1999). A range of stenohaline (*i.e.* exclusively salt water) invertebrate fossils indicates that fully marine salinities prevailed at the end of each sequence, at least in the western outcrop area (Namibia, Northern Cape). These invertebrates include echinoderms (starfish, crinoids, echinoids), cephalopods (nautiloids, goniatites), articulate brachiopods, bryozoans, foraminiferans, and conulariids, among others. Primitive bony fish (palaeoniscoids), spiral “coprolites” attributable to sharks or eurypterids, as well as wood and trace fossils are also recorded from mudrock facies at the tops of DSII (Ganikobis Shale Member), DS III (Hardap Member) and DSIV (Nossob Shale Member, as well as base of the Prince Albert Formation (Ecca Group) in southern Namibia and, in the last case at least, in the Northern Cape near Douglas (McLachlan and Anderson 1973, Veevers *et al.* 1994, Grill 1997, Bangert *et al.* 1999, Pickford & Senut 2002, Evans 2005). The Ganikobis (DSII) fauna has been radiometrically dated to *c.* 300 Ma, or end-Carboniferous (Gzhelian), while the Hardap fauna (DSIII) is correlated with the *Eurydesma* transgression of earliest Permian age (Asselian) that can be widely picked up across Gondwana (Dickens 1961, 1984, Bangert *et al.* 1999, Stollhofen *et al.* 2000). The distinctive thick-shelled bivalve *Eurydesma*, well known from the Dwyka of southern Namibia, has not yet been recorded from the main Karoo Basin, however (McLachlan and Anderson 1973). The upper part of DSIV, just above the Dwyka / Ecca boundary in the western Karoo Basin (*i.e.* situated within the basal Prince Albert Formation), has been radiometrically dated to 290-288 Ma (Stollhofen *et al.* 2000).

Low diversity ichnoassemblages dominated by non-marine arthropod trackways are widely associated with cold water periglacial mudrocks, including dropstone laminites, within the Mbizane Formation in the Main Karoo Basin (Von Brunn & Visser, 1999, Savage 1970, 1971, Anderson 1974, 1975, 1976, 1981, Almond 2008, 2009). They are assigned to the non-marine / lacustrine *Mermia* ichnofacies that has been extensively recorded from post-glacial epicontinental seas and large lakes of Permian age across southern Gondwana (Buatois & Mangano 1995, 2004). These Dwyka ichnoassemblages include the arthropod trackways *Maculichna*, *Umfolozia* and *Isopodichnus*, the possible crustacean resting trace *Gluckstadtella*, sinuous fish-fin traces (*Undichna*) as well as various unnamed horizontal burrows. The association of these interglacial or post-glacial ichnoassemblages with rhythmites (interpreted as varvites generated by seasonal ice melt), the absence of stenohaline marine invertebrate remains, and their low diversity suggest a restricted, fresh- or brackish water environment. Herbert and Compton (2007) also inferred a freshwater depositional environment for the Dwyka / Ecca contact beds in the SW Cape based on geochemical analyses of calcareous and phosphatic diagenetic nodules within the upper Elandsvlei and Prince Albert Formations respectively. Well-developed U-shaped burrows of the ichnogenus *Rhizocorallium* are recorded from sandstones interbedded with varved mudrocks within the upper Dwyka Group (Mbizane facies) on the Britstown sheet (Prinsloo 1989). Similar *Rhizocorallium* traces also described from the Dwyka Group of Namibia (*e.g.* the Hardap Shale Member, Miller 2008). References to occurrences of the complex helical spreiten burrow *Zoophycos* in the Dwyka of the Britstown sheet and elsewhere (*e.g.* Prinsloo 1989) are probably in error, since in Palaeozoic times this was predominantly a shallow marine to estuarine ichnogenus (Seilacher 2007).

Scattered records of fossil vascular plants within the Dwyka Group of the Main Karoo Basin record the early phase of the colonisation of SW Gondwana by members of the *Glossopteris* Flora in the Late Carboniferous (Plumstead 1969, Anderson & McLachlan 1976, Anderson & Anderson 1985 and earlier refs. therein). These records include fragmentary carbonized stems and leaves of the

seed ferns *Glossopteris* / *Gamgamopteris* and several gymnospermous genera (e.g. *Noeggerathiopsis*, *Ginkgophyllum*) that are even found within glacial tillites. More “primitive” plant taxa include lycopods (club mosses) and true mosses such as *Dwykea*. It should be noted that the depositional setting (e.g. fluvial *versus* glacial) and stratigraphic position of some of these records are contested (cf Anderson & McLachlan 1976). Petrified woods with well-developed seasonal growth rings are recorded from the upper Dwyka Group (Mbizane Formation) of the northern Karoo Basin (e.g. Prinsloo 1989) as well as from the latest Carboniferous of southern Namibia. The more abundant Namibian material (e.g. *Megaporoxyton*) has recently received systematic attention (Bangert & Bamford 2001, Bamford 2000, 2004) and is clearly gymnospermous (pycnoxylic, *i.e.* dense woods with narrow rays) but most cannot be assigned to any particular gymnosperm order.

Borehole cores through Dwyka mudrocks have yielded moderately diverse palynomorph assemblages (organic-walled spores, acanthomorph acritarchs) as well as plant cuticles. These mudrocks are interbedded with diamictites in the southern Karoo as well as within Dwyka valley infills along the northern margin of the Main Karoo Basin (McLachlan & Anderson 1973, Anderson 1977, Stapleton 1977, Visser 1989, Anderson & Anderson 1985). Thirty one Dwyka palynomorph species are mentioned by the last authors, for example. Anderson’s (1977) Late Carboniferous to Early Permian Biozone 1 based on Dwyka palynomorph assemblages is characterized by abundant *Microbaculispora*, monosaccate pollens (e.g. *Vestigisporites*) and nontaeniate bisaccate pollens (e.g. *Pityosporites*) (Stephenson 2008). Prinsloo (1989) mentions stromatolitic limestone lenses within the uppermost Dwyka Group in the Britstown sheet area. These may be comparable to interglacial microbial mats and mounds described from the Ganikobis Shale Member (DSII) of southern Namibia by Grill (1997) and Bangert *et al.* (2000).

Although a wide range of fossils are now known from the Dwyka Group, most sediments assigned to this succession are unfossiliferous (with the possible exception of microfossils). The overall palaeontological sensitivity of the Dwyka Group is therefore rated as low (Almond & Pether 2008). Any interglacial mudrocks and heterolithic successions (*i.e.* interbedded sandstones and mudrocks) are worth investigating for fossils, however. Since the Prieska-Copperton area lay on a basement high in Dwyka times (Fig. 4), interglacial mudrocks are unlikely to be well represented here. Late-glacial or post-glacial mudrocks, such as those containing a fairly rich shelly fossil record at Douglas in the Northern Cape (McLachlan & Anderson 1973) have been lost to erosion in the Prieska region.

4.3. Fossils in the Precambrian basement rocks

Although they may originally have contained microfossils (e.g. ancient bacteria) all these ancient basement metasedimentary rocks have been too intensely metamorphosed to contain fossils.

5. CONCLUSIONS & RECOMMENDATIONS

Palaeontological impacts and mitigation generally concern the construction phase rather than the operational phase of a development, unless this development involves ongoing excavation of bedrock (e.g. mining).

The inferred palaeontological sensitivity of all the rock units represented in the Plan 8 study area near Copperton is zero to low (Table 1; cf also Almond & Pether 2008). Impacts on fossil heritage are only likely during the construction phase, if at all. The scale of these impacts would be local and their magnitude low. The impact significance of the proposed wind energy development as far as fossil heritage is concerned is therefore considered to be LOW.

Given the zero to low palaeontological sensitivity of rocks in the region, the comparatively small footprint of the development and the shallow excavations envisaged, no further palaeontological mitigation is recommended for this development. There is no preference on palaeontological grounds for either of the two transmission line alternatives.

Should substantial fossil remains be exposed during construction, however, these should be safeguarded by the ECO, preferably *in situ*, and SAHRA should be notified by the ECO so that appropriate mitigation (e.g. recording, sampling or collection) can be undertaken.

6. ACKNOWLEDGEMENTS

Ms Louise Corbett of Environmental Services, Aurecon, Cape Town, is thanked for commissioning this study and for kindly providing all the necessary background information.

TABLE 1: FOSSIL HERITAGE IN THE COPPERTON AREA				
GEOLOGICAL UNIT	ROCK TYPES & AGE	FOSSIL HERITAGE	PALAEONTOLOGICAL SENSITIVITY	RECOMMENDED MITIGATION
Gordonia Formation KALAHARI GROUP	mainly aeolian sands <i>plus</i> minor fluvial gravels, freshwater pan deposits PLEISTOCENE	calcretised rhizoliths & termitaria, ostrich egg shells, land snail shells, rare mammalian and reptile (e.g. tortoise) bones, teeth freshwater units associated with diatoms, molluscs, stromatolites <i>etc</i>	LOW	none recommended any substantial fossil finds to be reported by ECO to SAHRA
Mbizane Formation DWYKA GROUP	tillites, interglacial mudrocks, deltaic & turbiditic sandstones, minor thin limestones LATE CARBONIFEROUS – EARLY PERMIAN	sparse petrified wood & other plant remains, palynomorphs, trace fossils (e.g. arthropod trackways, fish trails, U-burrows) possible stromatolites in limestones	LOW	none recommended any substantial fossil finds to be reported by ECO to SAHRA
Uitdraai Formation BRULPAN GROUP	metamorphic rocks (e.g. quartzites, schists) MID PROTEROZOIC = LATE PRECAMBRIAN	none	ZERO	none recommended
Spioenkop Formation MARYDALE GROUP	metamorphic rocks (e.g. quartzites, schists, amphibolites) ARCHEAN = EARLY PRECAMBRIAN	none	ZERO	none recommended

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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 alternative energy 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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