Palaeontological heritage assessment: desktop study

PROPOSED WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE ON NAMIES WIND FARM (PTY) LTD NEAR AGGENEYS, NORTHERN CAPE PROVINCE

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EXECUTIVE SUMMARY

juwi Renewable Energies (Pty) Ltd is proposing to develop the Namies Wind Energy Facility (WEF), comprising between 45 and 58 wind turbines with a total generation capacity of 140 MW on a site located *c.* 27 km southeast of Aggeneys in the Northern Cape. The site lies on farms Namies Suid (Remainder of Farm 212) and Vogelstruishoek (Portion 1 of Farm 88) and is 13,012 ha in extent.

The study area for the proposed Namies WEF, *including* alternative transmission line corridors and access roads, is underlain at depth by one to two billion year old Precambrian basement rocks of the Namaqua-Natal Province that are highly metamorphosed and entirely unfossiliferous. Apart from the rugged slopes of the Namiesberge inselberg on the northern margin of the area and occasional rocky outliers further south, these ancient basement rocks are largely mantled by a variety of Late Caenozoic superficial deposits such as stream alluvium, sheetwash sediments, suface gravels and wind-blown sands that are generally of low palaeontological sensitivity. In general, the various Late Caenozoic superficial sediments represented within the Namies WEF study area (*including* the transmission line corridors and access roads) are either largely unfossiliferous (*e.g.* scree, surface gravels) or only very sparsely fossiliferous (*e.g.* aeolian sands, younger alluvium). In the latter case the fossils concerned are probably of widespread occurrence elsewhere.

Important Miocene vertebrate faunas, including 15 to 16 million year old mammal and reptile remains, are recorded from ancient fluvial sediments of the Koa River Valley (*e.g.* at Bosluis Pan, *c*. 50 km SSW of the study site). This defunct drainage system, a former major tributary of the Orange River, runs from south to north across the Pofadder 1: 250 000 sheet area and is marked by relict pans, fluvial sediments and wind-blown sands. The Namies WEF study area overlaps the potentially fossiliferous Koa River Valley region (1) at the south-western tip of Vogelstruishoek, where no major new infrastructure is planned, as well as (2) along the existing transmission line corridor from south of the Ghaamsberg to Aggeneys (Bloemhoek 61, Aggeneys 56; See map Fig. 3). However, fossiliferous fluvial sediments have not yet been recorded from this northern sector of the Koa River Valley and, if present, they are likely to be deeply buried beneath superficial sediments (*e.g.* younger alluvium, aeolian sands). Likewise the chances of buried fossiliferous crater lake sediments, such as have yielded Cretaceous dinosaur remains at Kangnas *c*. 100 km to the southwest, are considered to be remote within the Namies WEF study site. Significant impacts on subsurface fossils are therefore not anticipated here.

There are no preferences on fossil heritage grounds for any of the alternative transmission line routes, access roads, wind turbine technologies (2.4 MW *versus* 3.5 MW turbines) or wind turbine layouts. In all cases the impact significance of the proposed development is assessed as LOW (negative). The impact significance of the no-go option of not proceeding with the proposed WEF is NEUTRAL.

It is concluded that the Namies WEF study area, including alternative transmission line corridors and access roads, is of LOW palaeontological sensitivity. Significant impacts on palaeontological heritage resources due to the proposed alternative energy development are not anticipated. Therefore, pending the discovery of significant new fossil remains during development, no further specialist palaeontological heritage studies or mitigation are recommended for this project.

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

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

1. INTRODUCTION AND BRIEF

The company *juwi* Renewable Energies (Pty) Ltd (*juwi*) is proposing to develop a wind energy facility (WEF), known as the Namies Wind Energy Facility, comprising between 45 and 58 wind turbines with a total generation capacity of 140 MW. The WEF will be located approximately 26 km southwest of Pofadder and 27 km southeast of Aggeneys, Northern Cape, on farms Namies Suid (Remainder of Farm 212) and Vogelstruishoek (Portion 1 of Farm 88) (Figs. 1 & 2). The study site is approximately 13,012 ha in extent while the project footprint equates to less than 0.5% of the total farm area.

The main infrastructural components of the proposed Namies WEF of relevance to the present palaeontological heritage assessment are:

- Between 45 and 58 wind turbines of 2.4 to 3.5 MW generation capacity with concrete foundations (26 m^2 for each turbine). Two proposed layouts are under consideration;
- Underground cabling between the turbines (*c*. 1 m deep);
- On-site substation (*c*. 12 000 m^2);
- Hard standing areas for cranes adjacent to each turbine position (2 304 m^2);
- Internal service and access roads (7 m wide, *c*. 47 km long). The road configuration will depend on the final turbine layout. Optional access roads include the Loop 10 gravel road, an unnamed gravel road from Pofadder to the site, and the “Pofadder road” leading from the Loop 10 gravel road towards the Namies Farmstead (Fig. 2);
- Stormwater infrastructure;
- A maintenance and storage building *plus* laydown area;
- Fencing and gates;
- 132 kV or 220 kV transmission lines connecting the WEF with the existing electricity grid near Aggeneys. Two route alternatives are under consideration (Fig. 2). The preferred route (Alternative 1, *c*. 37 km long) would be constructed adjacent to the existing 400 kV Eskom transmission line. The transmission line corridor / servitude will pass though the farms Vogelstruis Hoek 88 portion 1; Kykgat 87 portion 0; Kykgat 87 portion 1; Kykgat 87 portion 2; Bloemhoek 61 portion 0; Wolfkop 627 portion 0; Aggenys 56 portion 0 & Aggenys 56 portion

1. The Alternative 2 route (*c*. 38 km long) would exit the WEF site from the south and run adjacent the Loop 10 road.

In terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, a Scoping Phase and an EIA are required to be undertaken for this proposed project. Aurecon South Africa Pty (Ltd) (Contact details: PO Box 494, Cape Town 8000. www.aurecongroup.com. Tel: 021 526 5737) has been appointed by *juwi* Renewable Energies (Pty) Ltd as the independent environmental consultants to undertake the required Scoping Phase and Environmental Impact Assessment (DEA Ref.no. 14/12/16/3/3/2/550). The present palaeontological desktop study contributes to the EIA phase heritage impact assessment for the Namies Wind Energy Facility.

The approach to this desktop palaeontological heritage study is briefly as follows. Fossil bearing rock units represented within the study area are determined from geological maps and satellite images (Section 2). Known fossil heritage from each rock unit is inventoried from scientific literature, previous assessments of the broader study region (*e.g.* Almond 2012), and the author's field experience and palaeontological database (Section 3). Based on this data the palaeontological heritage sensitivity of the study area is assessed, with recommendations for any further specialist studies during the EIA phase (Section 4).

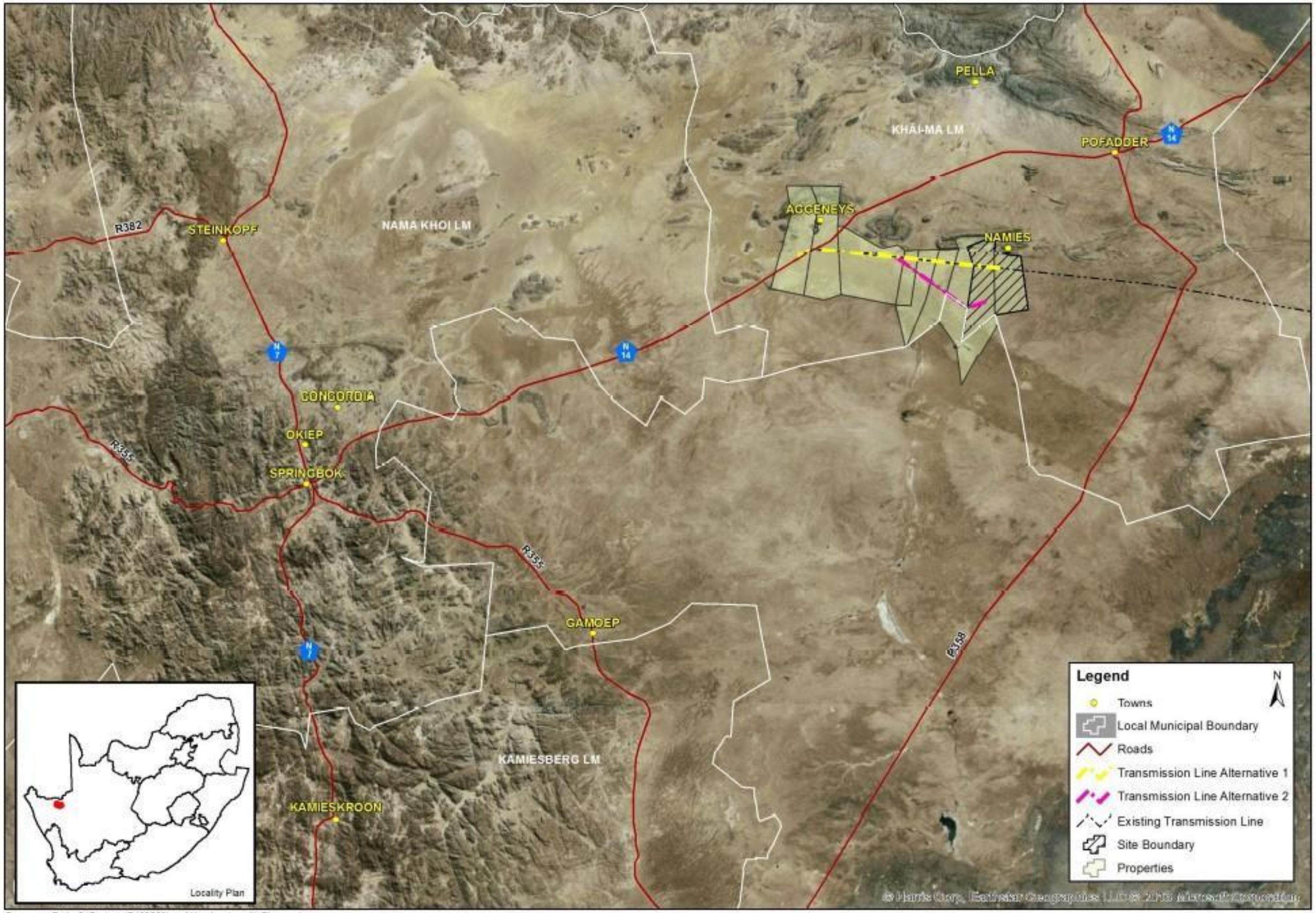

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Fig. 1. Satellite image showing the location of the proposed Namies Wind Energy Facility on the south side of the N14 tar road, *c.* 27 km southeast of Aggeneys and *c.* 26 km southwest of Pofadder, Northern Cape (Image abstracted from the Final Scoping Report by Aurecon South Africa (Pty) Ltd, August 2013).

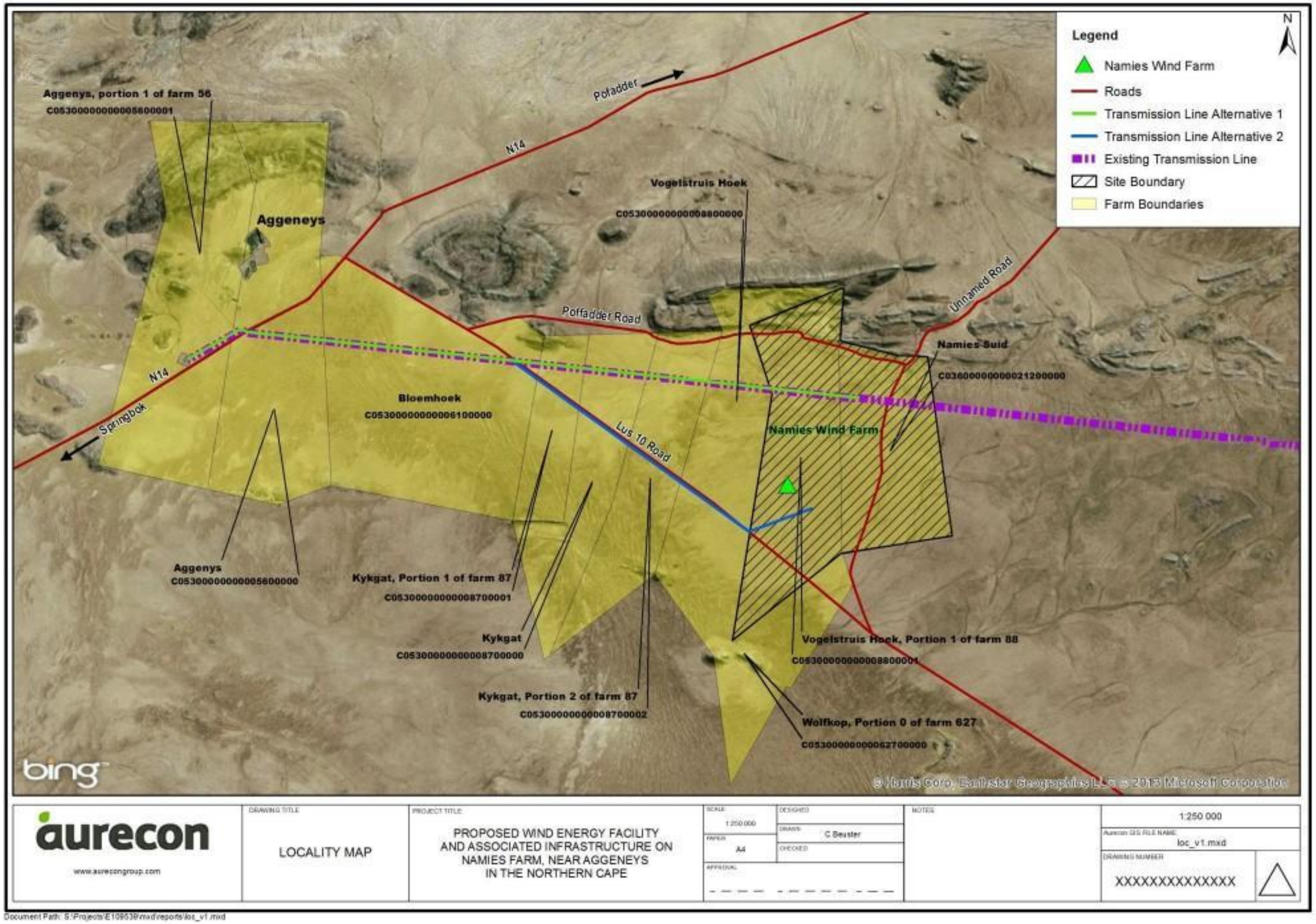

Fig. 2. Outline map of the proposed Namies Wind Energy Facility near Aggenys. The core study site is the shaded area on Farms Namies Suid (Remainder of Farm 212) and Vogelstruishoek (Portion 1 of Farm 88). Also shown are the two transmission line route alternatives: Alternative 1 (green) and Alternative 2 (blue) (Image abstracted from the Final Scoping Report by Aurecon South Africa (Pty) Ltd, August 2013).

1.1. Legislative context of this palaeontological study

The proposed Namies Wind Energy Facility study area in the Northern Cape is underlain by potentially fossil-rich sedimentary rocks of Tertiary or Quaternary age (Sections 2 and 3). The construction phase of the development may entail substantial surface clearance and excavations into the superficial sediment cover as well as locally into the underlying bedrock, notably for wind turbine installations, standing areas, underground cables, administrative buildings, onsite substation, transmission lines and new access roads. In addition, substantial areas of bedrock may be sealed-in or sterilized by infrastructure such as lay-down areas, standing areas, access roads and construction camps. All these developments may adversely affect fossil heritage preserved at or beneath the surface of the ground within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good. Once constructed, the operational and decommissioning phases of the wind energy facility are unlikely to involve further adverse impacts on palaeontological heritage.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (1999) 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 have been developed by SAHRA (2013).

1.2. Approach to the palaeontological heritage assessment

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 been compiled Almond & Pether 2008). The potential 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 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 assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment 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. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) 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, *i.e.* The South African Heritage Resources Agency, SAHRA, for the Northern Cape (Contact details: Mrs Colette Scheermeyer, P.O. Box 4637, Cape Town 8000. Tel: 021 462 4502. Email: cscheermeyer@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. Assumptions & limitations

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 palaeontological field studies in the Pofadder – Aggeneys region, the main limitations are:

- High levels of bedrock cover by thick alluvial and colluvial soils, windblown sands and other superficial deposits;
- The lack of detailed palaeontological field studies within the region.

Confidence levels in the conclusions presented here are nevertheless moderately high.

1.4. Information sources

The information used in this desktop study was based on the following:

1. The Final Scoping Report (August 2013) for the Namies WEF produced by Aurecon South Africa (Pty) Ltd (Report Number 8252);

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations as well as previous palaeontological assessment studies in the Aggeneys region by the author (See also reference list);

3. The author's previous field experience with the formations concerned and their palaeontological heritage (See also review of Northern Cape fossil heritage by Almond & Pether 2008, as well as Almond 2008).

2. GEOLOGICAL OUTLINE OF THE STUDY AREA

The Namies WEF study area comprises arid desert terrain in the Bushmanland region to the southeast of Aggenys and mainly lies on the southern side of the Namiesberge inselberg (1 163 m amsl). The flat to gently sloping areas at the foot of the Namiesberge, where the wind farm infrastructure will be sited, are situated at elevations of between 900 and 1 020 m amsl, with a general slope to the southwest towards the ancient (Tertiary) valley of the Koa River.

The Koa River is a defunct south bank tributary of the River Orange that can be traced right across the Pofadder 1: 250 000 sheet 2918. In the Mid Miocene Epoch the Koa River flowed northwards towards Ghaamsberg and then turned towards the west past Aggeneys, finally feeding into the palaeo-Orange River near Henkries (Malherbe *et al*. 1986, De Wit 1990, 1993, 1999, De Wit *et al*. 2000, Partridge *et al.* 2006, Almond 2008). The course of the Koa River Valley can be readily seen on satellite images where it is marked by intermittent pans and a veneer of orange-brown Kalahari wind-blown sands (See arcuate band of yellow Q-s_1 on the geological map Fig. 3). Mid Miocene climates were markedly wetter and drainage systems more active than in the immediately preceding and following periods. The Mid Miocene Koa River drained an extensive area of the southwestern interior plateau, reworking diamond-bearing gravels of the earlier, west-flowing Karoo River system that had once drained the continental interior and its kimberlite pipes during the Late Cretaceous. In the late Miocene / Pliocene increasingly arid climates led to choking of the waning Koa River by alluvial fans as well as extensive pedocrete formation. By the Plio-Pleistocene the Koa's headwaters had been captured by the Krom River in the west and the Sak River / Carnarvon Leegte system in the east, the latter flowing episodically into the Orange *via* the Hartebeest River (De Wit 1993, 1999).

Bedrock exposure within the Namies WEF study area is largely restricted to the rocky slopes of the Namiesberge in the north as well as occasional low basement outcrops in the flatter southern region. The rest of the area is mantled by sandy and gravelly superficial deposits that are incised by a number of shallow, NE-SW flowing ephemeral streams.

The geology of the study area is shown on 1: 250 000 geological map 2918 Pofadder (Council for Geoscience, Pretoria) (Fig. 3) (Agenbacht 2007). The Namiesberge Inselberg as well as the scattered basement inliers to the south are built of a variety of resistant-weathering igneous and high grade metamorphic rocks of Late Precambrian (Mokolian / Mid-Proterozoic) age. The various rock units - mainly gneisses, schists, quartzites and amphibolites - are listed in the legend to the geological map (Fig. 3). These basement rocks are assigned to the **Namaqua-Natal Province** and are approximately one to two billion years old (Cornell *et al.* 2006, Moen 2007, Agenbacht 2007).

The flatter portions of the study area – including those that will be directly affected by the proposed WEF development - are underlain by a range of unconsolidated superficial sediments of Late Caenozoic age. These include **Quaternary to Recent sands and gravels** of probable braided fluvial or sheet wash origin (**Q-s$_2$** in Fig. 3), as well as the veneer of downwasted suface gravels and colluval (rocky scree) deposits that are not indicated separately on the geological map. These youthful superficial sediments are locally overlain, and perhaps also underlain, by unconsolidated aeolian (*i.e.* wind-blown) sands of the Quaternary **Gordonia Formation** (**Kalahari Group**) (**Q-s$_1$** in Fig. 3; orange dunes on satellite images). All these sediments can be broadly subsumed into the Late Cretaceous to Recent **Kalahari Group**, the geology of which is reviewed by Partridge *et al.* (2006). The Gordonia dune sands are considered to range in age from the Late Pliocene / Early Pleistocene to Recent, dated in part from enclosed Middle to Later Stone Age stone tools. Note that the recent extension of the Pliocene - Pleistocene boundary from 1.8 Ma back to 2.588 Ma would place the Gordonia Formation almost entirely within the Pleistocene Epoch.

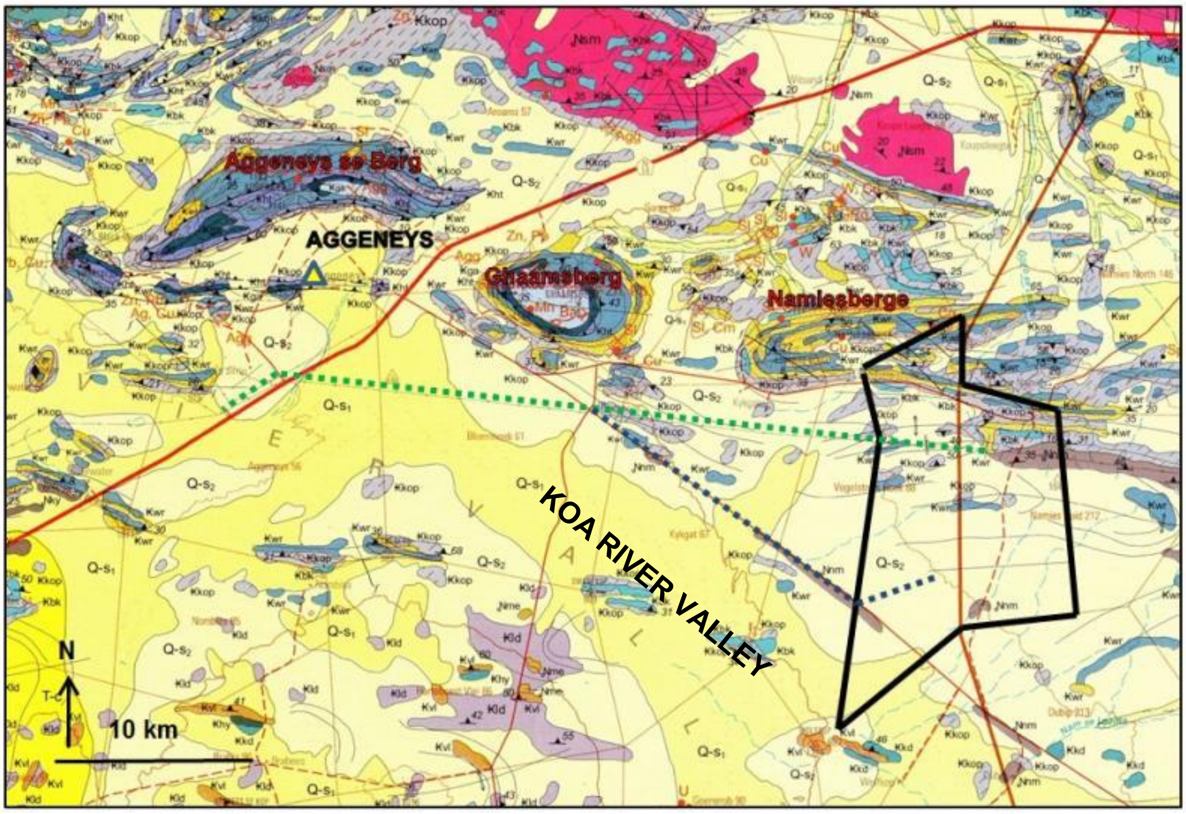

Fig. 3. Extract from 1: 250 000 geological map 2918 Pofadder (Council for Geoscience, Pretoria) showing the location (black polygon) of the study area for the proposed Namies Wind Energy Facility to the south of the Namiesberge near Aggeneys, Northern Cape. The dotted lines show transmission line route Alternative 1 (green) and Alternative 2 (blue). Geological units mapped within the core study area and within the transmission line corridors include:

(a) Mid Proterozoic (Mokolian) igneous and metamorphic basement rocks: Kwr (blue-grey & yellow) = WORTEL FORMATION (Bushmanland Group, Aggenys Subgroup); Kbk (blue-green) = BRULKOLK FORMATION (Bushmanland Group); Kkop (grey) = KOEIPOORT GNEISS (Gladkop Metamorphic Suite).

(b) Late Caenozoic superficial sediments: Q-s$_1$ (medium yellow) = red aeolian sands of the GORDONIA FORMATION (Kalahari Group); Q-s$_2$ (pale yellow) = sand, scree, rubble and sandy soil. Note the arcuate Koa River Valley (medium yellow) to the southwest of the WEF study area.

3. OVERVIEW OF PALAEONTOLOGICAL HERITAGE WITHIN THE STUDY REGION

Fossil biotas recorded from each of the main rock units mapped within the Namies WEF study area are briefly reviewed below (Based largely on Almond 2008, Almond & Pether 2008, Almond 2012 and references therein).

The Mid Proterozoic basement rocks of the **Namaqua-Natal Province** are entirely unfossiliferous (Almond & Pether 2008) and will not be treated further here.

Late Cretaceous dinosaur bones - the ornithischian *Kangnasaurus* - and ostracods have been recorded from coarse volcanic crater lake sediments from Kangnas near Goodhouse on the Orange River, some 100 km northwest of the Namies WEF study area (Rogers 1913, Haughton 1915, Cooper 1985, De Wit *et al*. 1992, Agenbacht 2007, Almond 2008). It is possible that comparable fossiliferous sediments within other Cretaceous to Early Tertiary volcanic craters are hidden beneath the superficial sediment cover in the study area, but this is considered to be unlikely.

An important Early to Middle Miocene vertebrate faunule has been recorded from alluvial deposits (gravels, grits and lenses of sand, clay) of the **Koa River Palaeo-valley** system at Bosluis Pan, some 50 km SSW of the Namies WEF site. The fauna has been dated to 15-16 Ma and is reviewed by Senut *et al*. (1996; see also Malherbe *et al*. 1986, De Wit 1999, Partridge *et al*. 2006, Agenbacht 2007, Almond 2008). It includes rare bones, tusks, molars and numerous tooth fragments of *Gomphotherium*, a four-tusked, browsing proboscidean with characteristic rounded (mastodont) tooth cusps. There are also crocodile teeth and tortoise shell fragments, as well as remains of grazing elephant shrews, giraffids, bovids, a rhinocerotid and air-breathing catfish. This fauna is obviously related to the much richer, and slightly older (17.5 Ma), Miocene fauna from the famous Arris Drift locality on the lower Orange / Gariep River, S. Namibia (Almond 2009). Crocodile and giraffid fossils at Bosluis Pan indicate warmer, more tropical conditions prevailed in the Mid Miocene than today. The inferred feeding habits of the mammals (*e.g.* browsing gomphotheres, grazing elephant shrews) suggest a riparian woodland habitat in a regionally arid setting, with both browse and grass available locally.

The Namies WEF study area overlaps the potentially fossiliferous Koa River Valley region (1) at the south-western tip of Vogelstruishoek, where no major new infrastructure is planned, as well as (2) along the existing transmission line corridor from south of the Ghaamsberg to Aggeneys (Bloemhoek 61, Aggeneys 56; See map Fig. 3). However, fossiliferous fluvial sediments have not yet been recorded from this northern sector of the Koa River Valley and, if present, they are likely to be deeply buried beneath superficial sediments (*e.g.* younger alluvium, aeolian sands). Significant impacts on subsurface fossils are therefore not anticipated here.

The various younger superficial 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, Brink & Rossouw 2000, Rossouw 2006). 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.

The fossil record of the **Kalahari Group** as a whole is generally sparse and low in diversity; no fossils are recorded here in the recent Pofadder geology sheet explanation by Agenbacht (2007). 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 underlying lime-rich bedrocks 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*), tortoise remains and shells of land snails (*e.g. Trigonephrus*) (Almond 2008, Almond & Pether 2008). Other fossil groups such as freshwater bivalves and gastropods (*e.g. Corbula, Unio*) and snails, ostracods (seed shrimps), charophytes (stonewort algae), diatoms (microscopic algae within siliceous shells) and stromatolites (laminated microbial limestones) are associated with local watercourses and pans. Microfossils such as diatoms may be blown by wind into nearby dune sands (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. 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 and calcretes, notably those associated with ancient alluvial gravels (See Koa River Valley above). The younger (Pleistocene to Recent) **fluvial and alluvial sands and gravels** within the proposed development area are unlikely to contain any substantial fossil or subfossil remains.

4. CONCLUSIONS & RECOMMENDATIONS

The study area for the proposed Namies WEF, *including* alternative transmission line corridors and access roads, is underlain at depth by one to two billion year old Precambrian basement rocks of the Namaqua-Natal Province that are highly metamorphosed and entirely unfossiliferous. Apart from the rugged slopes of the Namiesberge inselberg on the northern margin of the area and occasional rocky outliers further south, these ancient basement rocks are largely mantled by a variety of Late Caenozoic superficial deposits such as stream alluvium, sheetwash sediments, suface gravels and wind-blown sands that are generally of low palaeontological sensitivity. In general, the various Late Caenozoic superficial sediments represented within the Namies WEF study area (*including* the transmission line corridors and access roads) are either largely unfossiliferous (*e.g.* scree, surface gravels) or only very sparsely fossiliferous (*e.g.* aeolian sands, younger alluvium). In the latter case the fossils concerned are probably of widespread occurrence elsewhere.

Important Miocene vertebrate faunas, including 15 to 16 million year old mammal and reptile remains, are recorded from ancient fluvial sediments of the Koa River Valley (*e.g.* at Bosluis Pan, *c*. 50 km SSW of the study site). This defunct drainage system, a former major tributary of the Orange River, runs from south to north across the Pofadder 1: 250 000 sheet area and is marked by relict pans, fluvial sediments and wind-blown sands. The Namies WEF study area overlaps the potentially fossiliferous Koa River Valley region (1) at the south-western tip of Vogelstruishoek, where no major new infrastructure is planned, as well as (2) along the existing transmission line corridor from south of the Ghaamsberg to Aggeneys (Bloemhoek 61, Aggeneys 56; See map Fig. 3). However, fossiliferous fluvial sediments have not yet been recorded from this northern sector of the Koa River Valley and, if present, they are likely to be deeply buried beneath superficial sediments (*e.g.* younger alluvium, aeolian sands). Likewise the chances of buried fossiliferous crater lake sediments, such as have yielded Cretaceous dinosaur remains at Kangnas *c*. 100 km to the northwest, are considered to be remote within the Namies WEF study site. Significant impacts on subsurface fossils are therefore not anticipated here.

There are no preferences on fossil heritage grounds for any of the alternative transmission line routes, access roads, wind turbine technologies (2.4 MW *versus* 3.5 MW turbines) or wind turbine layouts. In all cases the impact significance of the proposed development is assessed as LOW (negative). The impact significance of the no-go option of not proceeding with the proposed WEF is NEUTRAL.

It is concluded that the Namies WEF study area, including alternative transmission line corridors and access roads, is of LOW palaeontological sensitivity. Significant impacts on palaeontological heritage resources due to the proposed alternative energy development are not anticipated. Therefore, pending the discovery of significant new fossil remains during development, no further specialist palaeontological heritage studies or mitigation are recommended for this project.

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

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

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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.

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