Environmental Impact Assessment for the proposed Banna Ba Pifhu Wind Energy Project near Humansdorp, Eastern Cape: Final Environmental Impact Assessment Report

Chapter 12:

Impact on Palaeontology

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12 IMPACT ON PALAEONTOLOGY

12.1 INTRODUCTION

The extent of the proposed development falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

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

A desktop palaeontological impact assessment for the Banna Ba Pifhu Wind Energy EIA has accordingly been commissioned by Environmental Management Services of the CSIR, Stellenbosch, on behalf of WKN Windcurrent SA (Pty) Ltd.

12.1.1 Approach to the study

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

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

The potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. The currently recorded fossil heritage within each unit is determined from the published scientific literature and the author's field experience. This data is then used to assess the palaeontological sensitivity of each rock unit to development (*N.B.* A tabulation of palaeontological sensitivity of all formations in the Eastern Cape has already been compiled by Almond *et al*., 2008).

The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged. Adverse palaeontological impacts normally occur during the construction rather than operational phase. Mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) – is usually most effective during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority (*e.g.* SAHRA for the Eastern Cape, Heritage Western Cape for the Western Cape). 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.

12.1.2 Terms of Reference

The author has been contracted by the CSIR to carry out the following work for this project:

- Desktop review of all relevant palaeontological and geological literature, including geological maps, previous reports.
- Review plans and data on proposed development provided by the developer (*e.g.* location of footprint, depth and volume of bedrock excavation envisaged)

12.1.3 Assumptions and limitations

Note that while fossil localities recorded within the study area itself are obviously highly relevant, most fossil heritage is buried beneath the land surface or obscured by surface deposits (soil, alluvium *etc*) and vegetation cover. The hidden fossil resources therefore have to be *inferred* from palaeontological observations made within the same formations elsewhere in the region, or even further afield (*e.g.* an adjacent province). Here it is assumed that fossil heritage is fairly uniformly distributed throughout the outcrop area of a given formation. Experience shows that this assumption does not always hold. This is because the original depositional setting across a formation that may extend over hundreds of kilometres may vary significantly, with palaeoecological implications (*e.g,* from a shallow to deeper water environment), while fossils are often patchy in their occurrence. Furthermore, the levels of tectonic deformation (folding, cleavage development etc), as well as the intensity and nature of metamorphism and weathering experienced by a given formation may change markedly across its outcrop area. These factors may seriously compromise the preservation of fossil remains present within the original sedimentary rock.

12.1.4 Information sources

This desktop study is based on the following resources:

- The draft Background Information Document (BID) for the project produced by the CSIR and Public Process Consultants;
- Relevant published palaeontological and geological literature (listed under References, Section 12.7);
- Geological maps (notably 1: 250 000 map 3324 Port Elizabeth, Council for Geoscience, Pretoria);
- Google Earth satellite images of the study area;

- Previous palaeontological assessments for projects in the Jeffrey's Bay / Humansdorp area (*e.g.* Almond 2010a, 2010b, 2011);
- The author's fossil database and extensive palaeontological field experience in the Cape region.

12.1.5 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 wind 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.

12.2 DESCRIPTION OF ASPECTS OF THE PROJECT THAT POTENTIALLY COULD CAUSE IMPACTS ON PALAEONTOLOGY

The proposed Banna Ba Pifhu Wind Energy Project is located in an area that is underlain by potentially fossil-bearing sedimentary rocks of Palaeozoic and younger age (Section 12.3). The construction phase of the development will entail numerous and extensive excavations into the superficial sediment cover as well as the underlying bedrock. These notably include excavations for the maximum of 17 turbine foundations, buried cables and any new gravel access roads. In addition, substantial areas of bedrock will be sealed-in or sterilized by infrastructure such as standing areas for each wind turbine, lay down areas as well as the new gravel road system. All these developments may adversely affect potential fossil heritage 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 project will not involve further adverse impacts on palaeontological heritage.

12.3 DESCRIPTION OF AFFECTED ENVIRONMENT

12.3.1 General introduction to geology of the study area

As shown by Figure 12.1 the Banna Ba Pifhu study area comprises a gently hilly portion of the low-lying (*c.* 40-90m amsl) southern coastal plain situated between the Seekoei and Geelhoutboom Rivers south of Humansdorp. The area is currently put to agricultural use, apart from narrow bands of riverine vegetation along the banks of the Seekoei River, with scattered shallow vleis, dams and small streams.

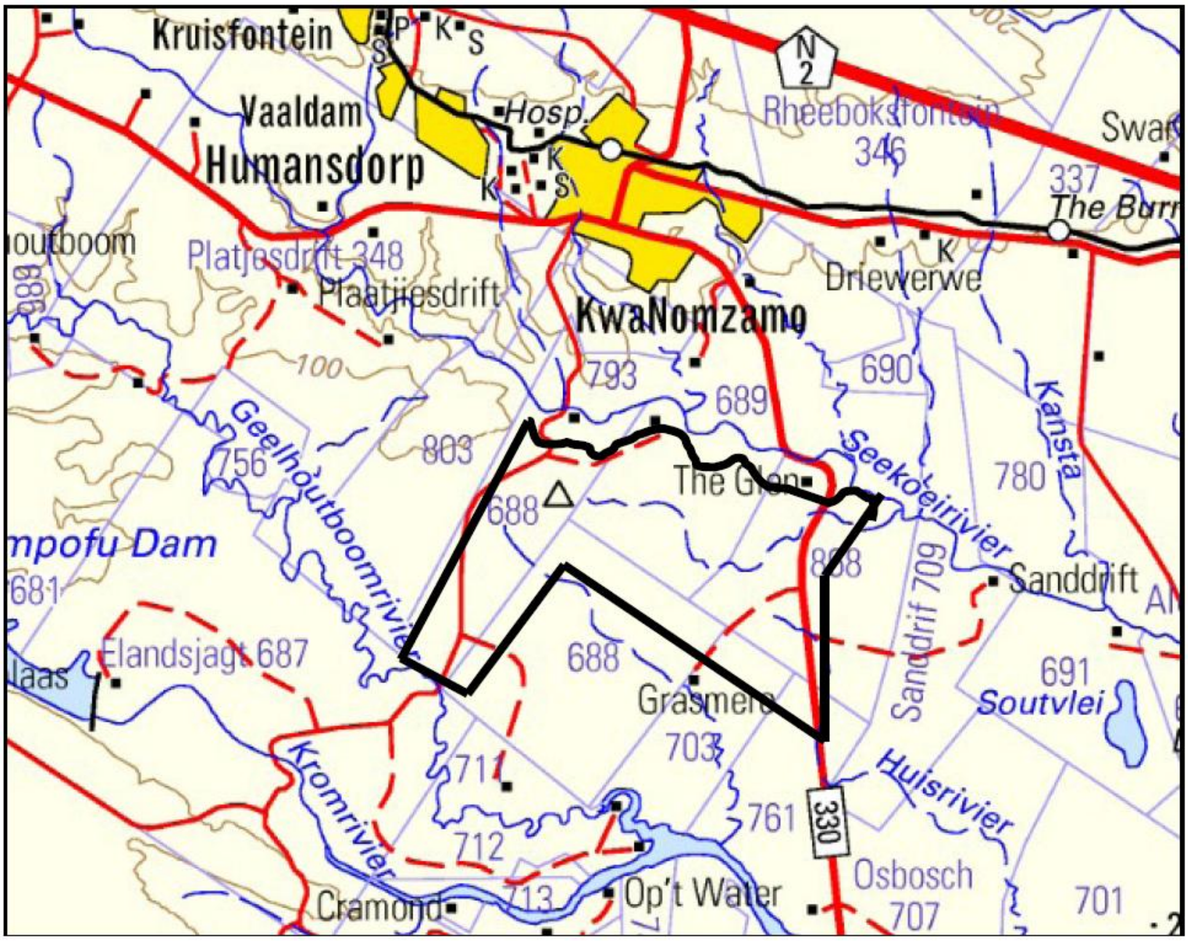

Figure 12.1. Extract from 1: 250 000 topographical map 3324 Port Elizabeth showing approximate outline of the proposed Banna Ba Pifhu Wind Energy Project on the south side of the Seekoeirivier and c. 3.5km south of Humansdorp, Eastern Cape Province (blue polygon).

The geology of the study area is depicted on the 1: 250 000 scale geological map sheet 3324 Port Elizabeth (Fig. 12.2). In addition to the explanation for this map published by Toerien & Hill (1989), useful background information on local geology and palaeontology is also given in the older sheet explanation for the coastal belt near the Gamtoos Valley by Haughton *et al.* (1937, p23) as well as the 1: 50 000 geology sheet explanation for Port Elizabeth - Uitenhage area by Le Roux (2000).

The study area overlies an extensive, low-lying, near-coastal surface of Late Tertiary or younger age that in this region is incised into readily-weathered and eroded mudrocks of the **Lower**

Bokkeveld Group (**Ceres Subgroup**). The Bokkeveld Group, the middle unit of the Palaeozoic Cape Supergroup, is a thick (*c*. 1.5 to 3.5km) succession of fossiliferous sedimentary rocks which was deposited in shallow marine to coastal settings of the epicontinental Agulhas Sea during the Early to Middle Devonian Period, about 400 to 375 million years ago These sediments accumulated on an area of continental shelf – the Cape Basin – which then lay towards the southern edge of the supercontinent Gondwana at moderately high palaeolatitudes (*c*. 70°S). Key accounts of Bokkeveld Group geology and sedimentology are given by Theron (1972), Tankard and Barwis (1982), Theron and Loock (1988), Theron and Thamm (1990), Theron and Johnson (1991), Broquet (1992) as well as Thamm and Johnson (2006).

The **Ceres Subgroup** (**Dc**) in the Port Elizabeth sheet area represents the lower, Early to Mid Devonian, portion of the Bokkeveld Group. It comprises three thick (300-500m) units of dark grey mudrocks that alternate with thinner (50-200m) sandstone-dominated units (Haughton *et al.* 1937, Le Roux 2000). The mudrocks are often silty, micaceous and highly cleaved due to Cape-age deformation (Haughton *et al.* 1937, p. 23). Sandstones (technically mostly impure wackes) frequently preserve sedimentological evidence of storm deposition, such as wave ripples and relicts of hummocky or swaley cross-lamination. Due to limited bedrock exposure, individual formations within the Ceres Subgroup are not mapped separately here. Levels of Cape-age (*i.e.* Permo-Triassic) tectonic deformation, including folding and cleavage, as well as of Tertiary weathering are generally high, often seriously compromising the preservation of palaeontological heritage within these beds (See, for example, recent impact studies on the southern coastal plain by Almond 2010a, b, Almond 2011).

The Ceres Subgroup bedrocks are locally mantled by Late Caenozoic “drift deposits” such as riverine and stream alluvium, vlei deposits and soils. These superficial sediments are not significant enough to be mapped at 1: 250 000 scale (Figure 12.2) and since they are generally of low palaeontological sensitivity will only be briefly considered below (Section 12.3.2).

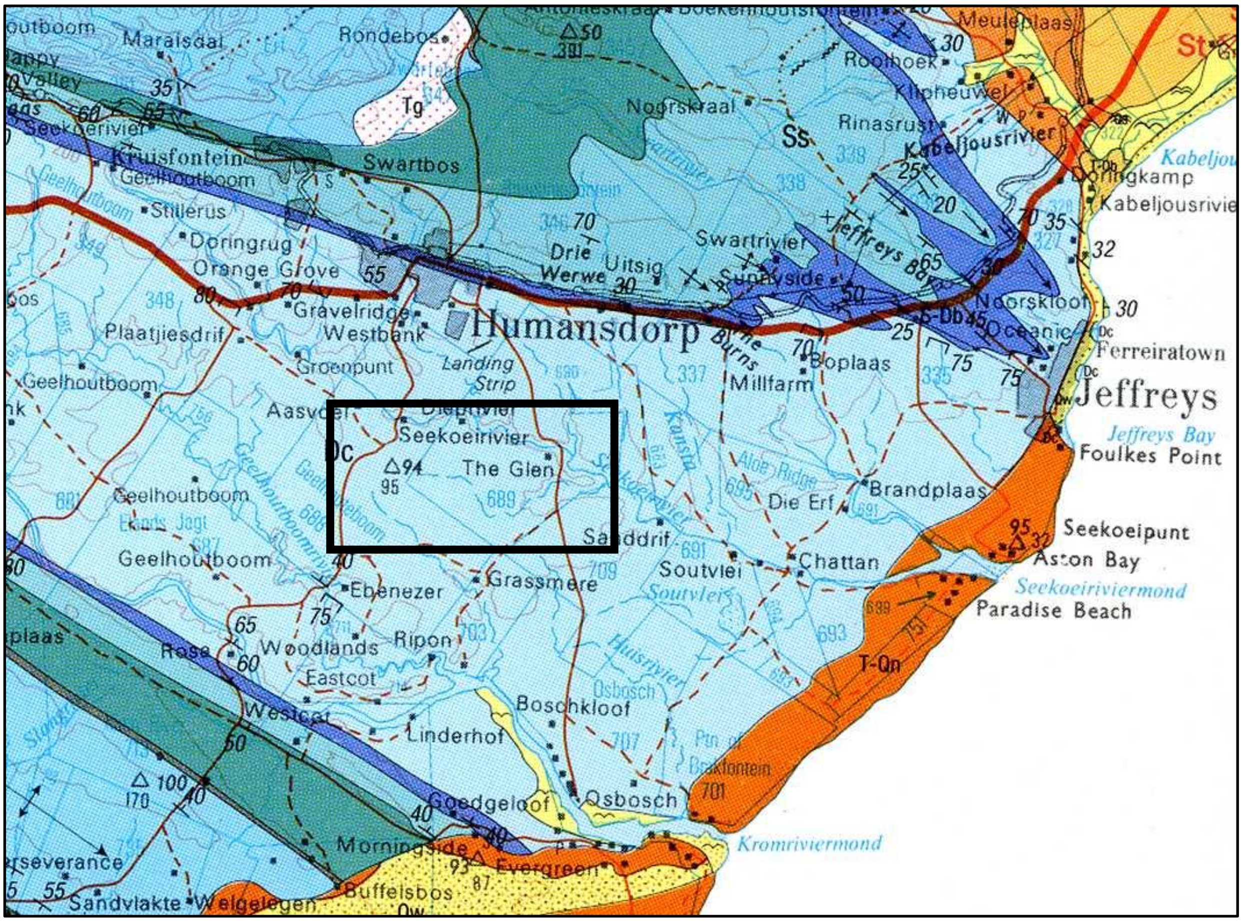

Figure 12.2 Geological map of the Humansdorp area, Eastern Cape Province, extracted from 1: 250 000 geological map sheet 3324 Port Elizabeth (Council for Geoscience, Pretoria). The *approximate* location of the proposed Banna Ba Pifhu Wind Energy Project is indicated by the black rectangle.

MAJOR GEOLOGICAL UNITS:
Bokkeveld Group: Dc (pale blue) = Ceres Subgroup (Lower Bokkeveld Group)

12.3.2 Palaeontological heritage within the study area

The overall palaeontological sensitivity of the marine **Bokkeveld Group** is *high* (Almond *et al.* 2008). The lower part of the Ceres Subgroup, especially in the less deformed outcrop areas of the Western Cape, is known for its rich fossil assemblages of shallow marine invertebrates of the Malvinokaffric Faunal Province of Gondwana (Cooper 1982, Oosthuizen 1984, Hiller & Theron 1988, Theron & Johnson 1991, MacRae 1999, Almond *in* De Beer *et. al*. 2002, Thamm & Johnson 2006, Almond 2008). Key fossil groups here include trilobites, brachiopods, various subgroups of molluscs (bivalves, gastropods, nautiloids *etc*), and echinoderms (starfish, brittle stars, crinoids, carpoids *etc*), with several minor taxa including corals, conulariids, tentaculitids and rare fish remains, among others. These shelly fossil assemblages – generally preserved as impressions or moulds – are especially abundant within the finer-grained, mudrock-dominated units such as the Gydo and Voorstehoek Formations in their more distal (offshore) outcrop areas. Remarkably diverse and well-preserved assemblages of marine trace fossils (burrows, trackways *etc*) occur in heterolithic (*i.e.* interbedded sandstone and mudrock) facies of the northern, more proximal outcrop area of the Bokkeveld Group (Swart 1950, Theron 1972, Oosthuizen 1984, Almond 1998a, 1998b, De Beer *et al*. 2002, Almond 2008).

Shelly fossils have not been extensively recorded from the more distal, southern outcrop area of the Bokkeveld Group, however, including the Port Elizabeth sheet area (*cf* Le Roux 2000). This may be due to the prevalence here of offshore, deeper water facies but important secondary influences include:

- deep chemical weathering of sediments beneath the “African Surface” which has obliterated many of the fossil moulds;
- intensive tectonic deformation of the Bokkeveld succession, with pervasive cleavage formation within the normally fossiliferous mudrocks (*N.B.* Most fossils are preserved and seen on bedding planes, which are rarely exposed here, rather than secondary cleavage planes which cut across fossil-rich layers); and
- the extensive mantle of drift deposits (including alluvium, downwasted lag gravels, soil and pedocretes) covering the Bokkeveld bedrock.

It is therefore notable that Haughton *et al.* (1937, p. 24) record a low diversity shelly invertebrate faunule from “Bokkeveld slates west of the Kabeljouws River”. The faunule consists entirely of distorted articulate and inarticulate brachiopods, including *Australoceolia*, chonetids, *Schuchertella* (“*Orthothetes*”), *Australospirifer* and *Orbiculoidea*. According to the same authors (*ibid*., p. 23) the Bokkeveld beds near Humansdorp are highly cleaved and “apparently unfossiliferous”. Any well-localized records of Bokkeveld fossils from new excavations in the study region would therefore be of scientific interest.

Neogene to Recent **alluvial deposits**, such as those expected along the Seekoeirivier, might also contain fossil remains of various types. These could include, for example, disarticulated to well-articulated skeletal remains (bones, teeth) or mammals, reptiles (*e.g.* tortoises), ostrich egg shells, freshwater molluscs, crabs, plant remains, trace fossils (*e.g.* rhizoliths or root-casts, termitaria and other invertebrate burrows, vertebrate tracks), and microfossils (*e.g.* pollens, spores, ostracods). In coarser sediments (*e.g.* conglomerates) fossils tend to be limited to robust, highly disarticulated and abraded specimens (*e.g*. rolled bones, teeth of vertebrates) but well-preserved skeletal remains of plants (*e.g.* wood, roots) and invertebrate animals (*e.g.* freshwater molluscs and crustaceans) as well various trace fossils may be found within fine-grained alluvium. Human artefacts such as stone tools that can be assigned to a specific interval of the archaeological time scale (*e.g.* Middle Stone Age) can be of value for constraining the age of Pleistocene to Recent drift deposits like alluvial terraces. Elevated, ancient (Tertiary) alluvial “**High Level Gravels**” tend to be coarse and to have suffered extensive reworking (*e.g.* winnowing and erosional downwasting), so they are generally unlikely to contain useful fossils.

12.4 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

In general, significant impacts on fossil heritage are only likely to occur during the construction phase of development. As outlined in the table below (Table 12.1), the significance of the impact of the Banna Ba Pifhu Wind Energy Project is assessed here as ***low***.

Once constructed, the operational and decommissioning phases of the wind energy project will not involve further adverse impacts on palaeontological heritage.

As far as fossil heritage resources within the Banna Ba Pifhu wind energy facility study area are concerned, any negative impacts due to damage or disturbance of fossils are **non-reversible**. Sealed-in subsurface fossils may become available for scientific study following removal of overlying infrastructure, however.

The irreplaceability of fossil heritage lost as a result of the construction phase of the Banna Ba Pifhu development is assessed as **low**. This is because comparable fossils can be expected to occur within the same formations outside the development footprint.

Should substantial fossil remains be exposed at any stage during development, these should be safeguarded - *in situ*, if feasible – and recorded by the responsible Environmental Control Officer (ECO) (photos, GPS readings). SAHRA should be alerted as soon as possible so that appropriate mitigation measures may be considered.

Table 12.1 provides a summary of the assessment of the impacts of the proposed wind farm on the Paleontological features of the site.

Specialist monitoring for fossil heritage is therefore not regarded as necessary for this project.

The ECO should be alerted to the (rather remote) possibility of shelly fossil remains being exposed in new bedrock excavations during construction (See, for example, illustrations in MacRae, 1999). Monitoring by the ECO of all substantial bedrock excavations for fossil remains is recommended (See Table12.2).

Note: Both alternative layouts were assessed (30.6 MW and 50 MW) and both assessment ratings are of **low significance** (Table 12.1).

Table 12.1. Impact assessment (for 30.6 MW and 50 MW alternatives)

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE									
Scenario									
Destruction, disturbance or sealing-in of buried fossils during bedrock excavations and construction work	**Negative** (without mitigation) **Positive** (with mitigation)	**Local, restricted to immediate develop-ment footprint**	**Permanent**	**Low**, since local fossil heritage is very sparse	**Improbable,** since local fossil heritage is very sparse	**Low**, since local fossil heritage is very sparse	**No professional palaeontological mitigation recommended.** ECO should alert SAHRA if substantial fossils are found during construction so that appropriate mitigation can be considered.	**Low**, since any mitigation measures, *e.g.* recording and collection of newly exposed fossils, will reduce the impacts further	**High**, based on extensive field experience of the rocks involved

Table 12.2. Monitoring programme

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
Destruction, disturbance or sealing-in of buried fossils during bedrock excavations and construction work.	Monitoring of fresh bedrock excavations for fossil remains.	Field observation. Recording of any fossil remains (GPS data, photos), safeguarding of specimens, reporting to SAHRA for appropriate mitigation (*i.e.* possible recording & sampling by professional palaeontologist)	Throughout construction phase of development.	ECO
Destruction, disturbance or sealing-in of buried fossils during bedrock excavations and construction work	Recording and rescue of any substantial occurrences of newly-exposed fossil remains reported by ECO.	Recording and judicious sampling of fossils together with relevant geological data (*e.g.* sedimentological & stratigraphic context, taphonomy). Curation of fossils in approved repository.	Whenever substantial fossil remains are exposed by bedrock excavation.	Professional palaeontologist

12.5 CONCLUSIONS

The Banna Ba Pifhu Wind Energy Project study area is entirely underlain by Devonian marine rocks of the Lower Bokkeveld Group (Ceres Subgroup). These shallow marine sediments are *potentially* highly fossiliferous, but in practice on the southern coastal plain their fossil content has been largely or completely obliterated by high levels of deformation (*e.g.* cleavage development, especially within mudrocks) and by deep chemical weathering. Their effective palaeontological sensitivity is consequently very low and developments here are rated as of *low* significance in fossil heritage terms. No specialist palaeontological mitigation is regarded as necessary for this wind energy project.

Should substantial fossil remains (*e.g.* fossil moulds of invertebrate shells) be exposed at any stage during development, these should be safeguarded - *in situ*, if feasible – and recorded by the responsible ECO (photos, GPS readings). SAHRA should be alerted as soon as possible so that appropriate mitigation measures may be considered.

The operational and decommissioning phases of the Banna Ba Pifhu Wind Energy Project are unlikely to have any significant impacts on local fossil heritage.

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