PALAEONTOLOGICAL IMPACT ASSESSMENT

QUNU WIND ENERGY PROJECT
O.R. TAMBO DISTRICT, EASTERN CAPE, RSA

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SUMMARY

Inno Wind (Pty) Ltd. are proposing to erect up to 10 wind turbines at a site just north of Qunu, south-west of Mthatha in the O.R. Tambo District in the Eastern Cape.

The area to be developed is underlain by rocks of the lower part of the Tarkastad Subgroup, i.e. the Katberg Formation. Early to Middle Triassic rocks of the Karoo Supergroup in other parts of South Africa have been extensively studied for their rich and diverse vertebrate fauna and associated trace fossils. These sequences also record a critical time in Earth's history, following the greatest mass extinction event ever to have occurred. Although relatively few fossils have been documented from the Katberg Formation in the vicinity of the study area, and in fact from all of the eastern parts of the Eastern Cape, there is every indication that this is due to a lack of prior investigations, and the region has great palaeontological potential.

The Katberg Formation in this area is therefore considered to be of **high palaeontological significance/sensitivity**, although **fossil densities** are apparently very **low** and of **sporadic occurrence**. Because of the sensitivity of these rocks, mitigation measures that should be considered by the applicant and competent authority are as follows: any excavation that exposes fresh Katberg Formation bedrock during development of the site must be closely monitored by the responsible Environmental Control Officer (ECO). Any fossil occurrences must be reported to SAHRA and/or a qualified palaeontologist for further assessment and excavation.

Damage to or destruction of any fossil during construction would be a **highly negative, permanent impact**. Discovery of fossils during excavation, followed by effective mitigation in collaboration with a palaeontologist, would result in the curation of new and important fossil material – therefore the development **could potentially have a positive**, **beneficial impact** on South Africa's palaeontological heritage.

Impact significance rating table as per CES template (see PIA Appendix I for definitions)

SIGNIFICANCE RATING							
Rock Unit	Temporal Scale	Spatial Scale	Degree of confidence	Impact severity		Overall Significance	
				with mitigation	without mitigation	with mitigation	without mitigation
Katberg Formation	permanent	international	possible	beneficial	very severe	beneficial	high negative

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INTRODUCTION

The development of the wind and solar farm at Qunu is an initiative of InnoWind (Pty) Limited. This study was commissioned by Gavin Anderson of Umlando cc. as part of a heritage impact assessment, on behalf of his client, Coastal and Environmental Services (CES). The purpose of this Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

National Heritage Monuments Act

The Qunu Wind Energy development is subject to assessment in terms of the following listed activities as per the 2010 Government *Listing Notices 1 (GN R544) & 3 (GN R546)* issued by the Department of Environmental Affairs (list of activities identified in terms of section 24(2)):

Activity No (s)		**Listed activity**
GN R544	**1 (i)**	The construction of facilities or infrastructure for the generation electricity where the electricity output is more than 10 megawatts but less than 20 megawatts
GN R544	**10 (i)**	The construction of facilities or infrastructure for the transmission and distribution of electricity outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts
GN R544	**23 (ii)**	The transformation of undeveloped, vacant or derelict land to residential, retail, commercial, recreational, industrial or institutional use, outside an urban area and where the total area to be transformed is bigger than 1 hectare but less than 20 hectares.
GN R546	**14 (a)i**	The clearance of an area of 5 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation in all areas outside urban areas.

The development may therefore not commence without an environmental authorisation from the competent authority (DEA – National).

In accordance with Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to archaeological and palaeontological heritage within the development footprint of the Qunu Wind Energy Project.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa’s natural or cultural heritage.

PROPOSED DEVELOPMENT

According to the BID issued by CES, the proposed development is a wind farm, hosting up to 10 turbines, with a potential power output of 20 MW. Other infrastructure associated with the proposed wind farm will be:

- Concrete foundations to support the wind towers,
- Approximately 3.5 meter wide internal access roads to each turbine
- Underground cables connecting each turbine to the other and to the substation
- A small building to house the control instrumentation and interconnection elements, as well as a storeroom for maintenance equipment.

Location of proposed development

The proposed site for the wind farm is 2 km east to north-east of Qunu as the crow flies, approximately 25 km south of Mthatha on the N2 (Fig. 1). The site is an 8.3 km^2 polygonal area on the eastern side of the national road (Figs 2 & 3). The centre of the site lies at the following GPS co-ordinates: 31° 46.236'S; 28° 39.815'E. (See Figs 1, 2 & 3).

FIG. 1 General location of the proposed Qunu Wind Energy Project

FIG. 2 Location and scale of the Qunu Wind Energy development

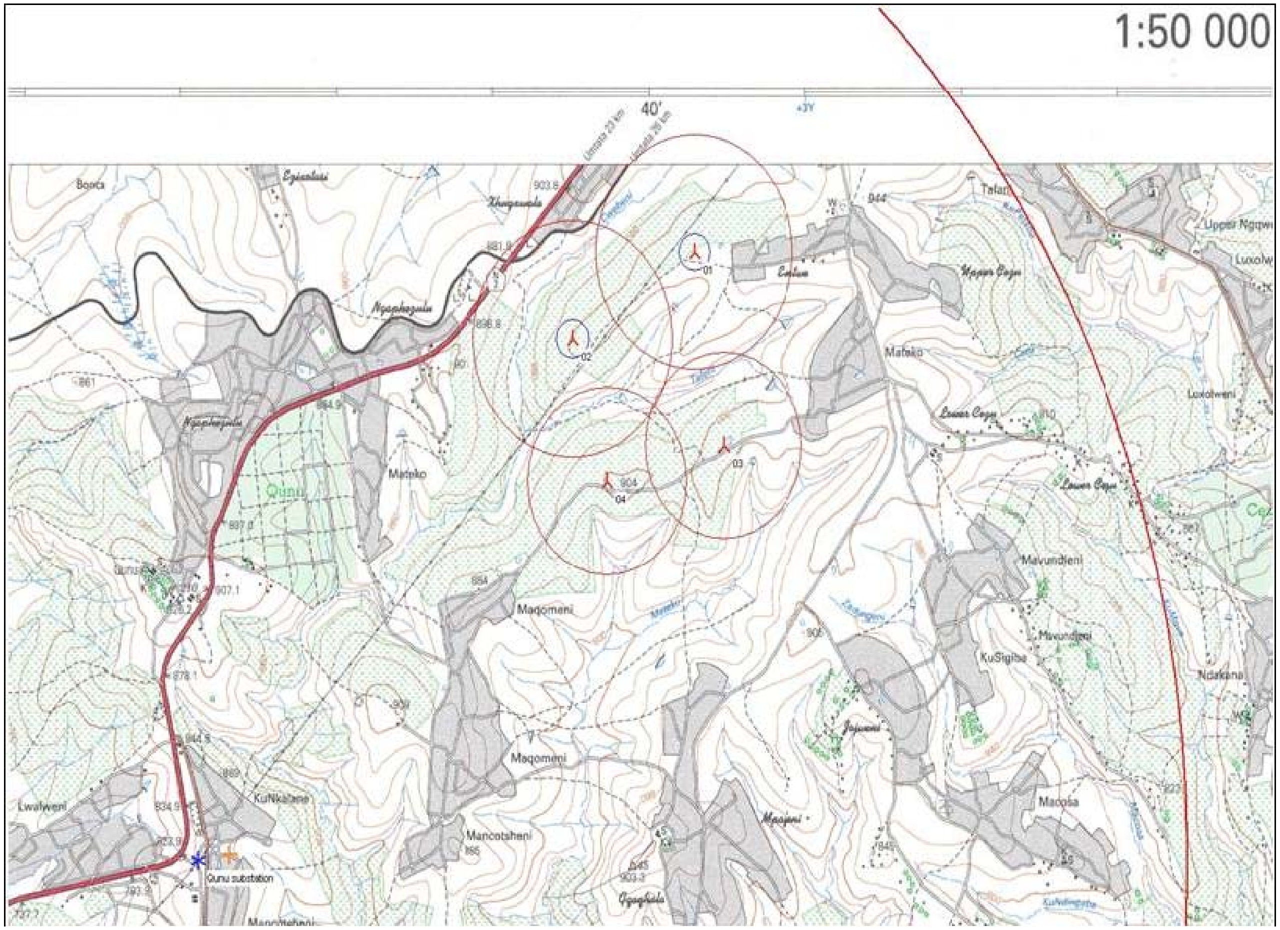

FIG. 3 A 1:50 000 topographic map illustrating a conceptual layout of 4 of the wind turbines (in red circles) on the Qunu site, east of the N2 and just north of Qunu (extracted from background information document issued by CES for the Qunu Wind Energy Project).

AIMS AND METHODS

This report represents the palaeontological component of a Phase 1 HIA, as per the latest version of the SAHRA guidelines (May 2007, revised 2009). The aims of the PIA are to assess the exposed and potential palaeontological heritage of the area targeted for development by:

1) identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;

2) assessing the level of palaeontological significance of these formations;

3) conducting fieldwork to assess the immediate risk to exposed fossils, and to document and sample these localities;

3) commenting on the impact of the development on these exposed and/or potential fossil resources;

4) making recommendations as to how the developer should conserve or mitigate damage to these resources.

Using appropriate geological (1:250 000) maps in conjunction with Google Earth, a basic assessment of the topography and geology of the area was made. A review of the literature on the geological formations exposed at surface within the development site, and the fossils that have been associated with these geological strata in the Mthatha region and elsewhere in South Africa, was undertaken. Specimen catalogues at the Albany Museum were consulted for additional information in this regard, as were previous PIA reports available on the internet. Dr Emese Bordy (Geology Department, Rhodes University), who is currently involved in detailed geological and palaeontological investigations in the region, provided valuable input.

A field investigation of the site was conducted on 24 February 2011, for the better part of a day, by a team of three (R. Prevec, C.C. Labandeira and J. Hepple), each experienced in looking for fossils. The aims of the fieldwork were to document any exposed fossil material, and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

GEOLOGICAL AND PALAEONTOLOGICAL CONTEXT

Regional and local geology

As indicated by the 1:250 000 geological map of the Mthatha (Umtata) region (3128; 1977; Fig. 5), the underlying rocks in the area fall within the palaeontologically highly significant **Beaufort Group,** of the Karoo Supergroup, in the south-eastern reaches of the main Karoo Basin. The entire area was heavily intruded by **dolerite dykes and sills** during Jurassic times (scattered pink areas in Fig. 5; Jd). Because of the igneous nature of these rocks, they have no palaeontological potential.

The Beaufort Group, underlain conformably by the predominantly deep-water mudrock of the Ecca Group, is characterized as a fluvial succession comprising upward-fining sequences of mudrock and sandstones, the latter mostly representing channel fills (see Hancox & Rubidge, 2001 for overview). The Beaufort Group (see Fig. 4) is divided into two subgroups, viz. the Upper Permian, Adelaide Subgroup (pale green – Pa in Fig. 5) and the overlying, Lower to Mid-Triassic, Tarkastad Subgroup (yellow-green - Trb, Trk in Fig. 5). Mthatha lies just east of the boundary between Tarkastad Subgroup exposures to the west, and Adelaide Subgroup to the East.

The area targeted for development is underlain by rocks of the **Tarkastad Subgroup** (Trk) (Fig. 5, outline). The Tarkastad Subgroup, which only crops out to the east of 24°E in the main Karoo Basin, consists of two clearly distinguishable formations: the lower predominantly arenaceous (sandy) Katberg Formation (Trk), and the overlying, predominantly argillaceous (shaly) Burgersdorp Formation (Trb) (Karpeta & Johnson, 1979; S.A.C.S., 1980), as indicated in the 1:250 000 geological map of the region (Fig.5), and more clearly, in the 1998 Explanation of the 1:500 000 general hydrogeological map of the Queenstown area (Smart, 1998). The study area is underlain by rocks of the **Katberg Formation**. This assessment has been confirmed by Dr E.M. Bordy (Geology Department, Rhodes University, Grahamstown; pers. comm.) who has worked extensively in the area (Fig. 6; Bordy *et al.*, 2010a,b).

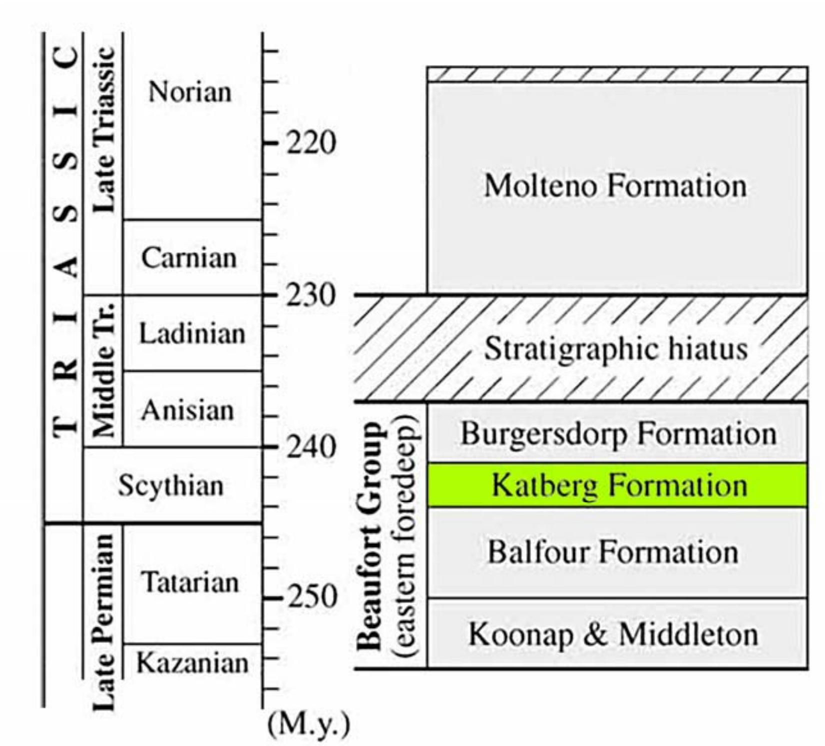

FIG. 4. Major lithostratigraphic subdivisions (Upper Permian to lower Upper Triassic) of the Karoo Supergroup, Main Karoo Basin of South Africa (adapted from Cataneanu *et al.*, 2005).

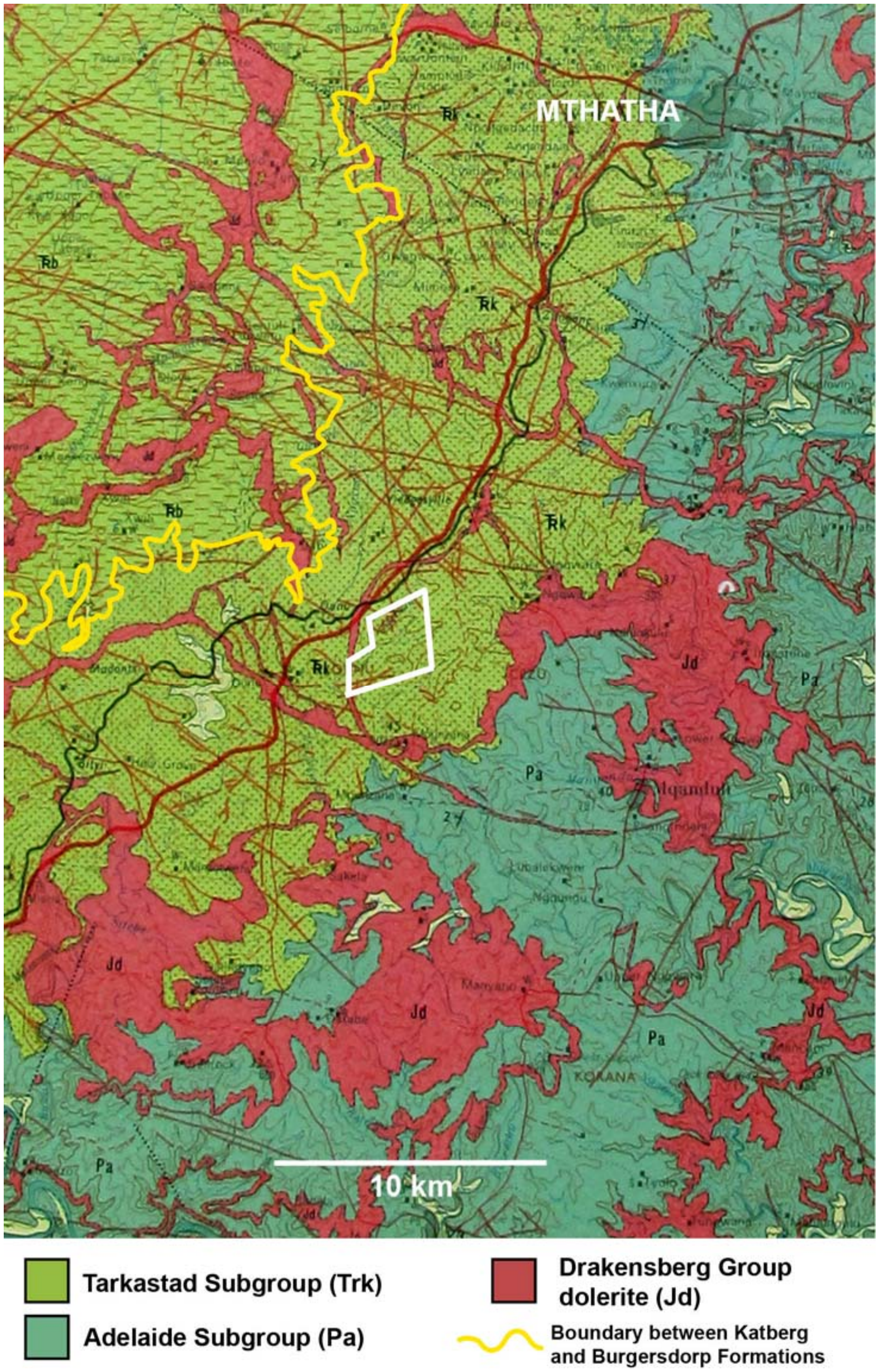

FIG. 5. Regional geology – Mthatha (formerly Umtata) area (1:250 000 geological map, 3128 Umtata; compiled by D.L. Caston, 1977; Council for Geoscience, Pretoria)

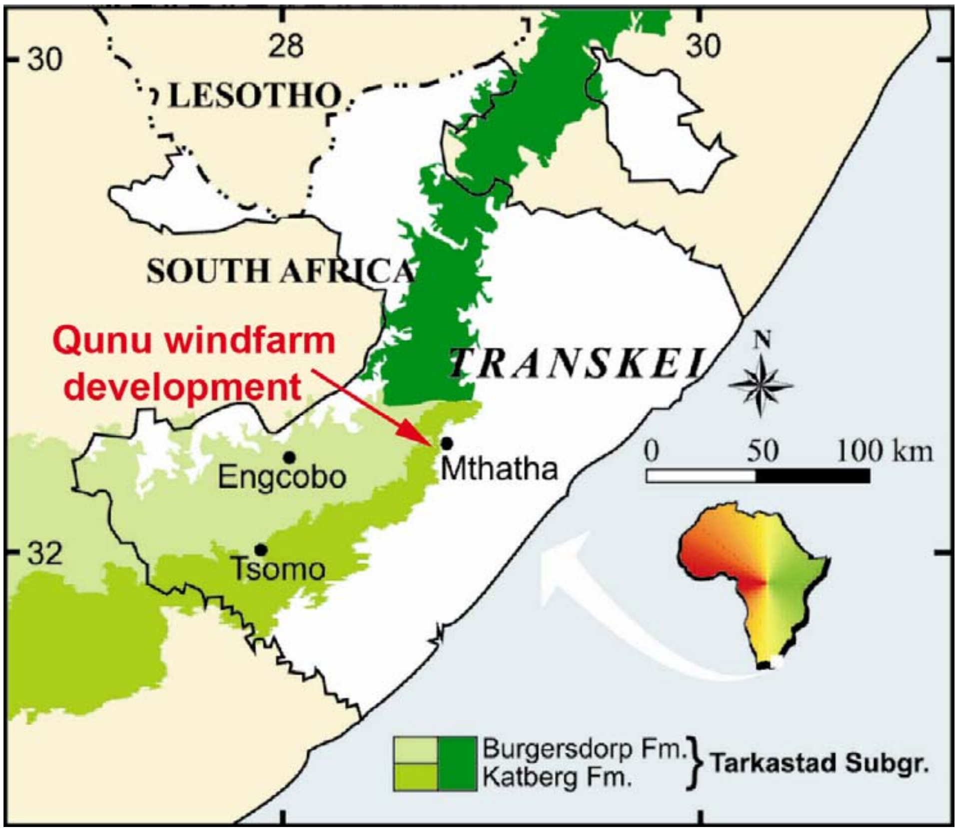

FIG. 6. Distribution and subdivision of the Tarkastad Subgroup (Beaufort Group) in the eastern parts of the Eastern Cape. Based on the 1998 Explanation of the 1:500 000 general hydrogeological map of the Queenstown area.

[Graphic created by E.M. Bordy (presented at 16th PSSA Congress, 2010) and reproduced here with permission].

The Katberg Formation comprises thick (up to 30 m) horizons of yellowish-grey to light greenish-grey sandstones and bluish-grey and reddish-grey mudstones. The sandstones characteristically comprise repeating, mutually truncating, trough cross-bedded channel-fill sand lenses, and mud-pebble conglomerates are often present at the base. Well-rounded pebbles are found in the sandstones. The sandstones are by far the dominant element, with mudstones tending to be thin (2-10m) and of limited lateral extent (Karpeta & Johnson, 1979; Hiller & Stavrakis, 1984, Groenewald, 1996). The formation reaches a maximum thickness of about 1000 m near East London, progressively thinning to the north (Hiller & Stavrakis, 1984; Neveling, 2004). The upper boundary of the Katberg Formation conformably grades into the Burgersdorp Formation. This transition zone is about 100 m thick, and lies within the uppermost *Lystrosaurus* Assemblage Zone (Neveling, 2004).

The Beaufort Group contains few mappable lithological markers and these are diachronous, so biostratigraphic criteria are used to refine further subdivision of the group. The biozones employed are based on the vertebrate fossil remains that are so abundant in these rocks (Fig. 7). In South Africa there has been a long tradition of vertebrate faunal studies and their biostratigraphic utilization in the Beaufort Group (Broom, 1906; Keyser & Smith 1977-78; Rubidge, 1995; Hancox & Rubidge, 2001; Cataneaunu *et al.*, 2005).

Palaeontological Heritage

The Beaufort Group is internationally recognised as a succession of great palaeontological value. These rocks provide a continuous and abundant record of terrestrial vertebrate life over a time-span ranging from the Middle Permian to the Middle Triassic, documenting important evolutionary events such as the transition from reptiles to mammals (e.g. Hancox & Rubidge, 2001; McCarthy and Rubidge, 2005), and reflecting the major biotic turmoil associated with the most dramatic extinction event in Earth's history – the Permian/Triassic extinction. This latter event occurred some 251 million years ago, and is marked in the fossil record by a massive turnover of plant and animal species (eg. Erwin 1994; Looy et al.. 2001; Smith & Ward, 2001; McCarthy & Rubidge, 2005; Smith & Botha, 2005).

Aside from the fascinating zoological and evolutionary implications of the Beaufort Group fossils, the profuse and continuous fossil record has provided an opportunity for palaeontologists to develop an effective biostratigraphic framework for a geological succession that has few geological features hinting at its subdivision (SACS, 1980; Rubidge, 1995; Hancox & Rubidge, 2001; Rubidge, 2005).

A literature review encompassing all the palaeontological and biostratigraphic research conducted on the Beaufort Group is beyond the scope of this report. See Groenewald & Kitching (1995), with updates by Hancox & Rubidge (2001), Rubidge (2005) and Botha & Smith (2006) for a list of fossil vertebrate taxa that have been found in the Katberg Formation (*Lystrosaurus* assemblage zone). Included are amphibians, captorhinids, eosuchids, dicynodonts, therocephalians and cynodonts. Vertebrate fossils are found predominantly in the mudrock sequences between channel sandstones, and skeletal and skull fragments may be locally abundant in channel lag conglomerates. Articulated skeletons of the vertebrate taxa *Lystrosaurus, Thrinaxodon, Galesaurus* and the small amphibian *Lydekkerina* are commonly found preserved in well-defined, blue-grey or red-brown calcareous nodules (Groenewald & Kitching, 1995). Additionally, numerous trace fossils have been recorded in the Katberg, both of invertebrate (Gastaldo & Rolerson, 2008) and vertebrate origin (Bordy et al., 2010a&b), as well as limited fossil insect remains (Groenewald & Kitching, 1995). Although only fragmentary fossil plants are known from the Katberg Formation (e.g. Gastaldo et al. 2005), the potential exists to find highly significant plant fossil localities within this rock unit.

Karpeta & Johnson (1979) stated that fossils are uncommon in the Tarkstad Subgroup in the Mthatha region. In fact, palaeontological investigation of the Eastern Cape, particularly in the area formerly known as the Transkei, has lagged behind that of the north-eastern and southern parts of the Main Karoo Basin. Historically, this has been for a number of reasons, including the perceived political instability of the region, physical remoteness of the region from main centers and what were previously hazardous and poorly maintained access roads. The dense vegetation and relative scarcity of outcrop (due to higher rates of chemical and physical weathering and gentler topography) in the region have also deterred palaeontologists - comparable time spent in the southern and western parts of the basin, which are more arid with sparser vegetation and better outcrop, promises much higher fossil returns.

However, recent work has shown that fossil occurrences within the Katberg Formation in the eastern parts of the Eastern Cape, are probably in line with abundances projected for exposures further west in the main Karoo Basin. Bordy *et al.* (2010a) found several vertebrate fossil localities and a trace fossil locality in the region, including very well-preserved specimens of the vertebrate taxa *Lystrosaurus* and *Thrinaxodon*. Clearly, the **palaeontological significance** of these poorly explored areas should not be underestimated (see Fig. 7), and is here rated as **high** (Table 1).

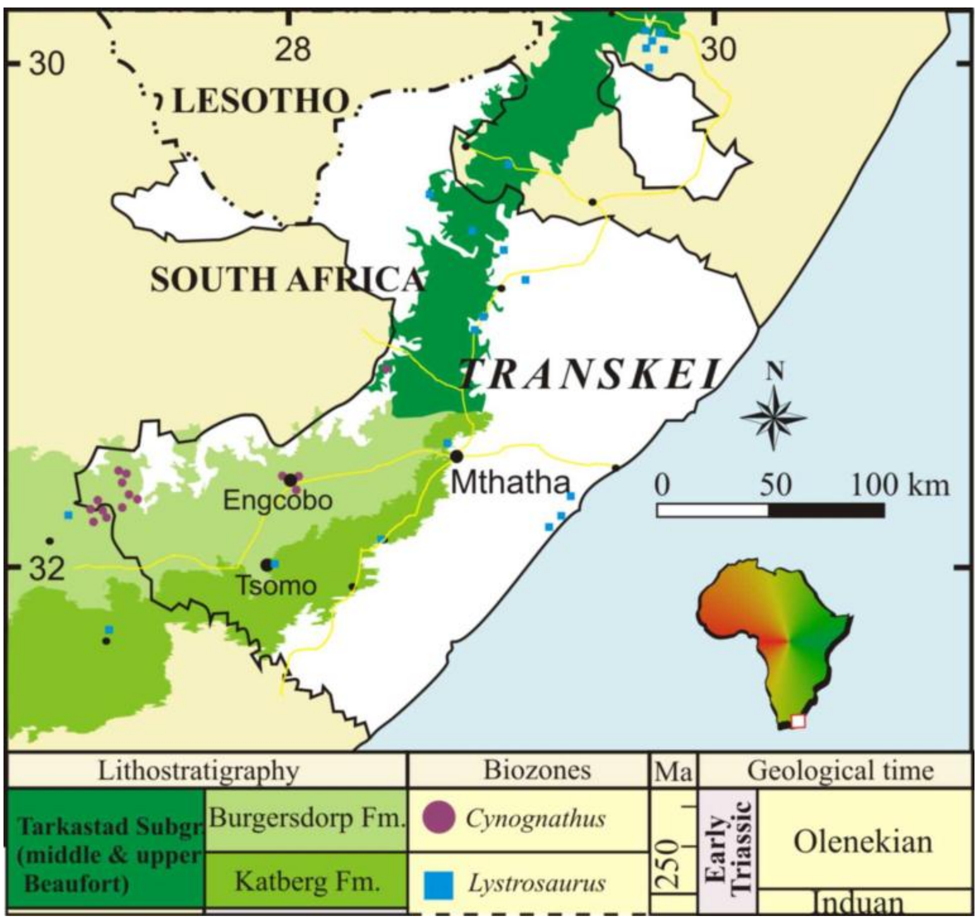

FIG. 7. Recorded occurrences in the eastern parts of the Eastern Cape of index fossils *Lystrosaurus* and *Cynognathus* (used in the subdivision of the Tarkastad Subgroup) [Graphic created by Bordy (2010a) and reproduced here with permission; data generated from literature and museum catalogues].

FIELD EXAMINATION OF DEVELOPMENT SITE

The proposed Qunu Wind Energy Project, involves the construction of wind turbines along two undulating ridges within the development site. The site is roughly bisected NE to SW by a streambed. The valley and rolling highland areas are well-vegetated with grassland floras. The only rock exposures observed were outcrops of coarse-grained sandstones typical of the Katberg Formation on the steeper slopes, with intercalated reddish mudrocks only exposed in erosion gullies transecting the slope contours in some areas, particularly the south-facing slopes of the hills in the northern part of the site. There was very little exposure in the river bed itself. The river became increasingly incised towards the NE, but the stream banks were almost entirely recent soils, without much exposure of bedrock. Reddish, sandy alluvium in the overbank area was observed being actively mined on an informal basis.

Investigation of the bedrock exposed within erosion gullies, yielded no fossil material, apart from abundant root fossils and rhizoconcretions in the red mudrocks, which appear to be mostly palaeosols - an ideal lithology for the preservation of fossil bone, but not for diagnostic plant fossil material.

FIG. 8. Site of the proposed Qunu Wind Energy development: best exposures of the potentially fossiliferous red mudrocks of the Katberg Formation, within erosion gullies in the north-western part of the property.

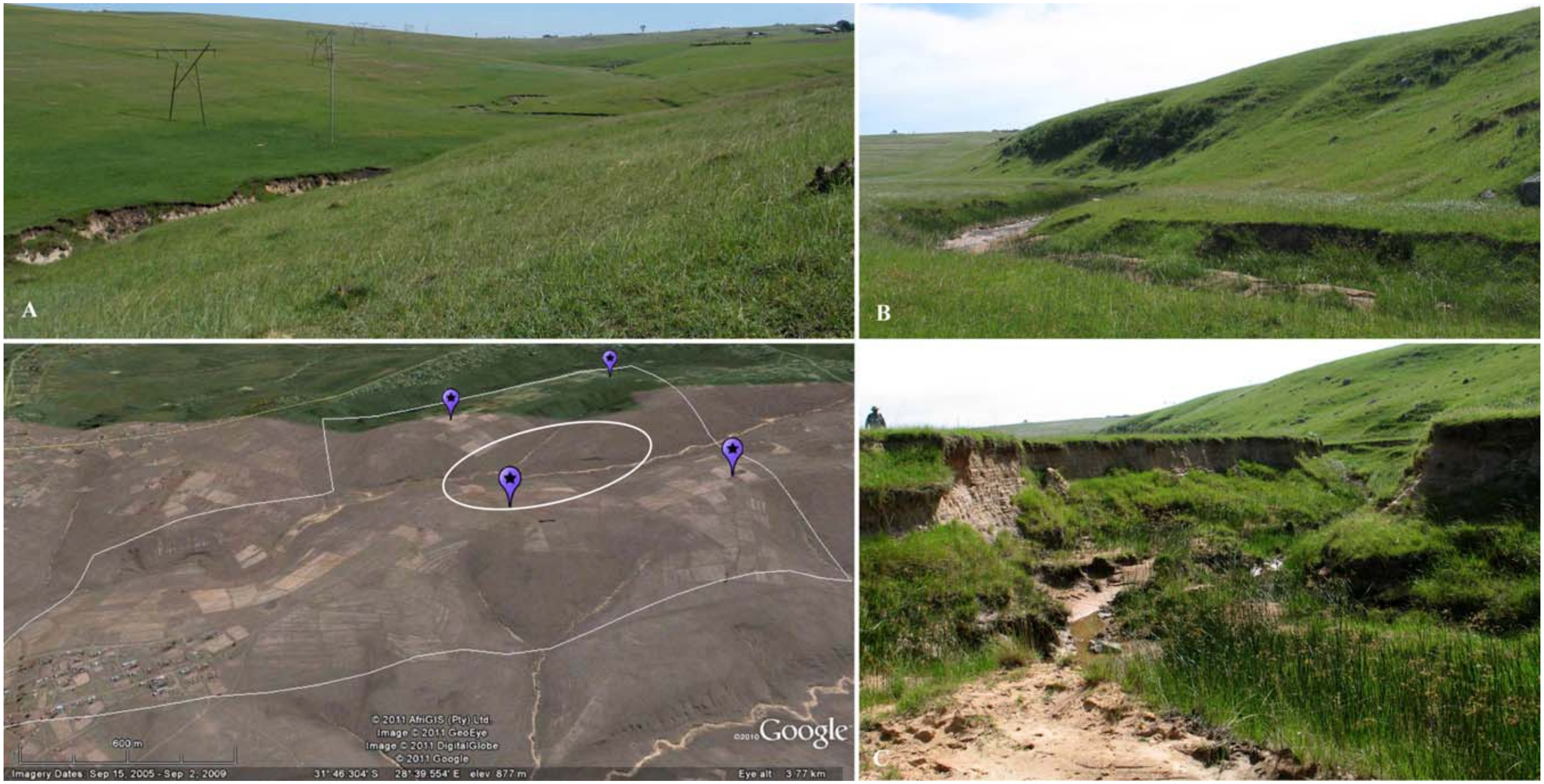

FIG. 9. Site of the proposed Qunu Wind Energy development: northern parts of the site – little in the way of rock exposure, apart from massive channel sandstones, and modern soils adjacent to the incised streambed.

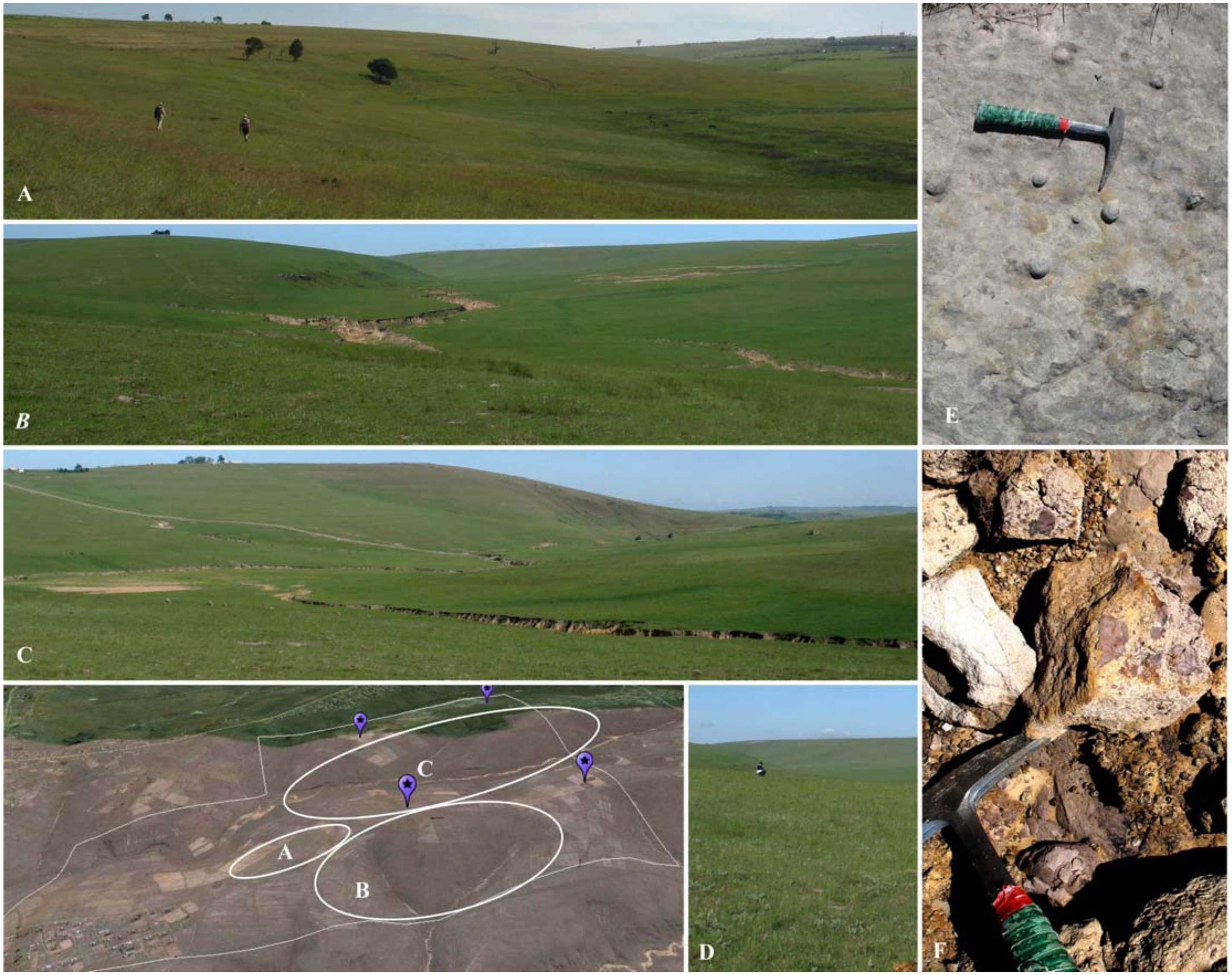

FIG. 10. Site of the proposed Qunu Wind Energy development: the gentle topography, and well-developed soils meant that the rolling green hills had little to offer in the way of bedrock exposure, apart from massive sandstones, typical of the Katberg Formation, containing abundant nodules (E), and mud clasts (F).

PREDICTED IMPACT OF PROPOSED DEVELOPMENT

The proposed development, involving the installation of wind turbines and infrastructure including roads and buildings, has the potential to impact directly on fossil heritage, as construction will inevitably require excavation of bedrock (Tables 1, 2). However, depending on the effectiveness of the management plan set in place, this could have a positive impact palaeontologically.

The region is highly weathered, and rock exposures are few and of poor quality, making exploration for fossils labour intensive and low yield. If excavations of fresh bedrock are adequately monitored during the course of the proposed development, then any fossil discovery made in the process could be seen as facilitating a significant scientific advancement.

Field investigations of the development site indicate that some of the highland areas may be underlain by dolerite, a rock type resistant to erosion and therefore commonly responsible for the creation of elevated areas in the topography of the region. This rock type is devoid of fossil potential, and therefore any excavations into dolerite do not require monitoring or mitigation in terms of palaeontological heritage. However, hills in the region may also be attributed to the presence of erosion-resistant sandstones of the Katberg Formation. These are interbedded with mud- and siltstones that do have potential to yield fossils.

Presumably the actual sites of individual turbine construction will be in highland areas, and are therefore less likely to result in the exposure of the sandstones and mudrocks of the Katberg Formation, but the construction of access roads and building foundations may well result in the excavation of palaeontologically significant bedrock.

Table 1: Palaeontological significance of geological units present on site

GEOLOGICAL UNIT				ROCK TYPE AND AGE	FOSSIL HERITAGE	VERTEBRATE BIOZONE	PALAEON-TOLOGICAL SENSITIVIY	RECOMMENDED MITIGATION
KAROO SUPERGROUP	DRAKENSBERG GROUP			dolerite dykes and sills (igneous intrusives)	none	none	**NIL**	none
	BEAUFORT GROUP	Tarkastad Subgroup	Burgersdorp Formation	predominantly argillaceous MIDDLE TRIASSIC (Olenekian to Anisian)		*Cynognathus* AZ		
			Katberg Formation	medium to coarse-grained sandstone dominated EARLY TRIASSIC (Induan, Scythian Stage)	vertebrate fossils including amphibians, captorhinids, eosuchids, dicynodonts, therocephalians and cynodonts and trace fossils	*Lystrosaurus* AZ	**High sensitivity**	regular monitoring of any excavations into bedrock; in the event of fossils being encountered, excavation should cease until a palaeontologist can assess, extract and document the find

Table 2: Significance rating table as per CES template (see PIA Appendix I for definitions)

SIGNIFICANCE RATING							
Rock Unit	**Temporal Scale** (duration of impact)	**Spatial Scale** (area in which impact will have an effect)	**Degree of confidence** (confidence with which one has predicted the significance of an impact)	**Impact severity** (severity of negative impacts, or how beneficial positive impacts would be)		**Overall Significance** (The combination of all the other criteria as an overall significance)	
				with mitigation	**without mitigation**	**with mitigation**	**without mitigation**
Katberg Formation	permanent	international	possible	beneficial	very severe	beneficial	high negative

Explanation: There is a **possibility** that fossils could be encountered during excavation of non-doleritic bedrock within the development footprint. These fossils would be of **international significance**. If effective mitigation measures were in place at the time of exposure, and they were successfully excavated for study, this would represent a **beneficial** impact. Alternatively, if fossil specimens were destroyed in the absence of adequate monitoring during construction activities, this would represent a **permanent, very severe, highly negative** impact on South Africa's palaeontological heritage.

That said, the possibility of encountering fossils in the region is fairly low in any small, localized region. Within the Katberg Formation, there is no way of assessing the likelihood of encountering fossils during excavation. As evidenced in other areas with exposures of Katberg Formation rocks, fossils may be apparently absent or very scarce over large areas, or it is possible to encounter locally dense accumulations.

To summarize, fossils within the Nqunu site could be characterized as **rare, but highly significant**, and any damage to, or loss of, these fossils due to inadequate mitigation would be a **highly negative palaeontological impact.** However, exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) to a qualified palaeontologist for excavation, could be seen as a **beneficial palaeontological impact**.

RECOMMENDATIONS/ MITIGATION

It should be emphasised that palaeontological impact of a development can be divided into two types – (1) destruction or disturbance of fossils already exposed on the surface (exposure through natural weathering processes or through previous excavations); (2) exposure and/or damage of subsurface fossils due to excavation into fresh bedrock.

When the potential exists for new fossils to be exposed through excavations, it is the responsibility of the on-site ECO to monitor excavation activities and report the occurrence of any fossiliferous material to SAHRA and an appropriate palaeontological expert, to allow the material to be thoroughly assessed, recorded and professionally excavated or sampled.

It should also be noted that it is not just the actual bone/plant material/shell etc. itself that is of interest and importance to a palaeontologist. Increasingly, scientists are appreciating the value of information evident in the immediate vicinity of fossils that is not necessarily inherent to the fossil itself, such as the geology of the host rock stratum, the orientation of individual fossil organs, organism associations, preservational features etc. These types of information can provide important clues about past environments, and can help to place fossils within their original context. These types of information can be lost through indiscriminate sampling by untrained personnel.

Additionally, fossil extraction can be a delicate process, employing great skill and experience, and it is not always easy to determine the physical extent of an individual specimen. During excavation, when any contact is made with underlying bedrock, the responsible Environmental Control Officer (ECO) must regularly inspect the freshly exposed rock for fossil evidence. Any finds must be reported to SAHRA and the Albany Museum, Grahamstown, so that they can be inspected by a qualified palaeontologist at the earliest opportunity and, if necessary, be adequately sampled or removed for curation and study. If feasible, the exposed fossil material should be photographed (with a scale), covered over with loose sediment, and the site carefully recorded (GPS reading/ 1:50 000 map/aerial photograph). The responsible ECO should immediately report the find to SAHRA and/or an appropriately qualified palaeontologist.

Once detailed plans elucidating precise positions of the turbines and associated infrastructure have been finalized, it will save the developers much time and effort were they to consult a geologist, to indicate whether the excavations will intersect dolerite or sedimentary successions. If sedimentary rocks underlie the localized developmental footprint, then the responsible ECO must regularly monitor the excavations for the presence of fossils. If the footprint is underlain by dolerite, no monitoring would be required for palaeontological mitigation purposes.

CONCLUSIONS

Although relatively few fossils have been documented from the Katberg Formation in the study area, and in fact in all the eastern parts of the Eastern Cape, there is every indication that this is attributable to a lack of prior investigations, and the region has great potential to improve our understanding of the life and geology of this critical time in Earth's history. The site earmarked for development at Qunu has accordingly been assigned a **palaeontological sensitivity rating of high** (Tables 1 and 2).

Developments in the Eastern Cape could make a significant contribution to the science through the excavation into underlying bedrock that would otherwise have remained covered by vegetation and soil – **provided that adequate monitoring and reporting procedures are adopted during excavation.**

If any fossils are exposed during construction, the Environmental Control Officer must be notified. The ECO should also make regular surveys of the excavation site so that any exposed fossils can be appropriately protected, and the discovery reported to a local palaeontologist for removal.

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QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr Rose Prevec has PhDs in Palaeontology and Plant Pathology from the University of the Witwatersrand (2005) and University of KwaZulu-Natal (1998) respectively. She specialises in research on South African Permian macrofossil floras, with an interest in taxonomy, biostratigraphy, and palaeoecological aspects such insect-plant interactions. She has held three postdoctoral fellowships, at Wits and Rhodes University, and is currently a Research Associate at the Albany Museum in Grahamstown. Dr Prevec has more than 10 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, eastern and north-eastern parts of the country. Her publication record includes multiple articles in internationally recognized journals. Dr Prevec is accredited by the Palaeontological Society of Southern Africa (society member for 13 years, and a member of the Executive Committee for 4 years).

Declaration of Independence

I, Rosemary Prevec, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

Dr Rosemary Prevec
Palaeontologist

PIA APPENDIX I: EXPLANATION OF RISK AND SIGNIFICANCE RATINGS
(Compiled by CES)

Table A1: Criteria used to rate the significance of an impact

Significance Rating Table	
Temporal Scale (The duration of the impact)	
Short term	Less than 5 years (Many construction phase impacts are of a short duration).
Medium term	Between 5 and 20 years.
Long term	Between 20 and 40 years (From a human perspective almost permanent).
Permanent	Over 40 years or resulting in a permanent and lasting change that will always be there.
Spatial Scale (The area in which any impact will have an affect)	
Individual	Impacts affect an individual.
Localised	Impacts affect a small area of a few hectares in extent. Often only a portion of the project area.
Project Level	Impacts affect the entire project area.
Surrounding Areas	Impacts that affect the area surrounding the development
Municipal	Impacts affect either the Local Municipality, or any towns within them.
Regional	Impacts affect the wider district municipality or the province as a whole.
National	Impacts affect the entire country.
International/Global	Impacts affect other countries or have a global influence.
Degree of Confidence or Certainty (The confidence with which one has predicted the significance of an impact)	
Definite	More than 90% sure of a particular fact. Should have substantial supportive data.
Probable	Over 70% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Only over 40% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact, or of the likelihood of an impact occurring.

Table A2: The severity rating scale

Impact severity (The severity of negative impacts, or how beneficial positive impacts would be on a particular affected system or affected party)	
Very severe	**Very beneficial**
An irreversible and permanent change to the affected system(s) or parties which cannot be mitigated. For example the permanent loss of land.	A permanent and very substantial benefit to the affected system(s) or parties, with no real alternative to achieving this benefit. For example the vast improvement of sewage effluent quality.
Severe	**Beneficial**
Long term impacts on the affected system(s) or parties that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these. For example, the clearing of forest vegetation.	A long term impact and substantial benefit to the affected system(s) or parties. Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example an increase in the local economy.
Moderately severe	**Moderately beneficial**
Medium to long term impacts on the affected system(s) or parties, which could be mitigated. For example constructing the sewage treatment facility where there was vegetation with a low conservation value.	A medium to long term impact of real benefit to the affected system(s) or parties. Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way. For example a 'slight' improvement in sewage effluent quality.
Slight	**Slightly beneficial**
Medium or short term impacts on the affected system(s) or parties. Mitigation is very easy, cheap, less time consuming or not necessary. For example a temporary fluctuation in the water table due to water abstraction.	A short to medium term impact and negligible benefit to the affected system(s) or parties. Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect	**Don't know/Can't know**
The system(s) or parties are not affected by the proposed development.	In certain cases it may not be possible to determine the severity of an impact.

Table A3: The rating of overall significance

<table>
<tr><th colspan="2">Overall Significance
(The combination of all the above criteria as an overall significance)</th></tr>
<tr><th>VERY HIGH NEGATIVE</th><th>VERY BENEFICIAL</th></tr>
<tr><td colspan="2">These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects.
Example: The loss of a species would be viewed by informed society as being of VERY HIGH significance.
Example: The establishment of a large amount of infrastructure in a rural area, which previously had very few services, would be regarded by the affected parties as resulting in benefits with VERY HIGH significance.</td></tr>
<tr><th>HIGH NEGATIVE</th><th>BENEFICIAL</th></tr>
<tr><td colspan="2">These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as HIGH will need to be considered by society as constituting an important and usually long term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light.
Example: The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated.
Example: The change to soil conditions will impact the natural system, and the impact on affected parties (such as people growing crops in the soil) would be HIGH.</td></tr>
<tr><th>MODERATE NEGATIVE</th><th>SOME BENEFITS</th></tr>
<tr><td colspan="2">These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial.
Example: The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.</td></tr>
<tr><th>LOW NEGATIVE</th><th>FEW BENEFITS</th></tr>
<tr><td colspan="2">These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect.
Example: The temporary change in the water table of a wetland habitat, as these systems is adapted to fluctuating water levels.
Example: The increased earning potential of people employed as a result of a development would only result in benefits of LOW significance to people who live some distance away.</td></tr>
<tr><th colspan="2">NO SIGNIFICANCE</th></tr>
<tr><td colspan="2">There are no primary or secondary effects at all that are important to scientists or the public.
Example: A change to the geology of a particular formation may be regarded as severe from a geological perspective, but is of NO significance in the overall context.</td></tr>
<tr><th colspan="2">DON'T KNOW</th></tr>
<tr><td colspan="2">In certain cases it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given the available information.
Example: The effect of a particular development on people's psychological perspective of the environment.</td></tr>
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