PROPOSED INFINITE PLAN 8 GRAHAMSTOWN WIND FARM, EASTERN CAPE PROVINCE OF SOUTH AFRICA

ENVIRONMENTAL IMPACT ASSESSMENT

Palaeontological Heritage Impact assessment for a proposed 80MW windfarm, 30km east of Grahamstown.

Prepared for:	Prepared by:
Coastal & Environmental Services	Rob Gess Consulting
P.O. Box 934 Grahamstown, 6140	Box 40, Bathurst, 6166 robg@imaginet.co.za
South Africa	South Africa

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1 BACKGROUND

Coastal and Environmental Services have been appointed to carry out a full Environmental Impact Assessment for an 80MW (2-3MW turbines) windfarm approximately 30 km east of Grahamstown.

Rob Gess Consulting was contracted to conduct a phase one Palaeontological Impact Assessment for this proposed development.

2 GEOLOGY AND PALAEONTOLOGY

The area intended for development overlies strata of the upper portion of the Cape Supergroup and lowermost portion of the unconformably overlying Karoo Supergroup. In addition, portions of the Cape Supergroup rocks are capped by relict patches of Silcrete formed as a product of deep leaching during the Cretaceous.

Cape Supergroup rocks represent sediments deposited in the Agulhas Sea, which had opened to the south of the current southern African landmass, in response to early rifting between Africa and South America during the Ordivician.

The Witteberg Group is the uppermost of three subdivisions of the Cape supergroup and was laid down during the Late Devonian.

The stratigraphically lowest Witteberg Group strata present belong to the Late Devonian (Famennian) Witpoort Formation (Lake Mentz Subgroup, Witteberg Group, Cape Supergroup), which are exposed at the centre of an anticline. This largely quatzitic unit represents mature sandy strata deposited along a linear barrier island type coast. Particularly around Grahamstown black shale lenses, interpreted as estuarine deposits preserved during brief transgressive events, have proved remarkably fossiliferous. A series of lenses at Waterloo Farm, to the south of Grahamstown, have provided southern Africa's most important Late Devonian locality, which has yielded at least 20 taxa of fossil fish (including jawless fish (Agnatha), armoured fish (Placodermi), spiny sharks (Acanthodii), sharks (Chondrichthyes), ray finned fish (Actinopterygii) and lobe finned fishes (Sarcopterygii) including Coelacanths (Actinistia), lungfish (Dipnoi) and Osteolepiformes. Dozens of plant and algal taxa, remains of giant eurypterids and other arthropods as well as abundant trace fossils have also been collected. The top of the Witpoort Formation coincides with the end of the Devonian and is similar in age to the end-Devonian extinction event. Witpoort Formation quartzites have yielded a range of plant stem taxa and trace fossils. Lag deposits of bone have not, as yet, been discovered, but may be expected.

The early to mid Carboniferous is represented by overlying mudstone and sandy units of the remainder of the Lake Mentz Subgroup (Witteberg Group, Cape Supergroup). These were deposited as sediment during the last phase of the Agulhas Sea, by which time it was much restricted and was possibly (at least partially) cut off from the open sea. The Waaipoort Formation (uppermost Lake Mentz Subgroup Witteberg Group, Cape Supergroup) provides evidence for a post-extinction Agulhas Sea fauna, dominated by a range of ray-finned-fish (Actinopterygii), but also containing a relict shark and 2 types of spiny sharks (Acanthodii).

The strata of the Karoo Supergroup were deposited within the Karoo sedimentary Basin, which resulted from shortening and thickening of the southern margin of Africa, with coeval folding and uplift of the Cape Supergroup strata along its southern margin. Lowermost Karoo strata of the Dwyka and lower Ecca Groups were affected by folding in the vicinity of the Cape Fold Belt.

The Dwyka Group (Karoo Supergroup), particularly here in the south of the basin consists almost exclusively of diamictite known as the Dwyka tillite. This is a distinctive rock type which, when freshly exposed, consists of a hard fine-grained blueish-black matrix in which abundant roughly shaped clasts are embedded. These vary greatly in both lithology and size. During the formation of the Dwyka, beginning in the late Carboniferous, southern Africa drifted over the south pole, whilst simultaneously, the world was experiencing a cold episode. Glaciers flowing into the flooded Karoo basin broke up, melted and discharged a mixture of finely ground rock flour and rough chunks of rock. These formed the matrix and clasts of the Dwyka tillite. Within the study area fossils are not known from the Dwyka Group (Karoo Supergroup).

During the Cretaceous and early Tertiary Periods much of Africa was weathered down to a number of level horizons collectively known as the African Surface. The area in the vicinity of Grahamstown was reduced to a flat plain close to sea level, remnants of which are referred to as the Grahamstown Peneplane. During the Tertiary, mudstones, shales and diamictites were leached to considerable depth, transforming them into soft white kaolin clay. Silica, iron and magnesium from these rocks was carried in solution by groundwater and deposited near the ground surface due to steady evaporation of mineral rich waters. This lead to the formation of a hard mineralised capping layer, often consisting of silicified soil. Resultant silcretes are referred to as the Grahamstown Formation. Though occasional occurrences of root and stem impressions have been recorded from the Grahamstown Formation it is generally considered unfossiliferous.

With subsequent reduction of the relative sea level, deep valleys have carved back from the retreating coastline, cutting deep valleys and catchment areas into the African Surface.

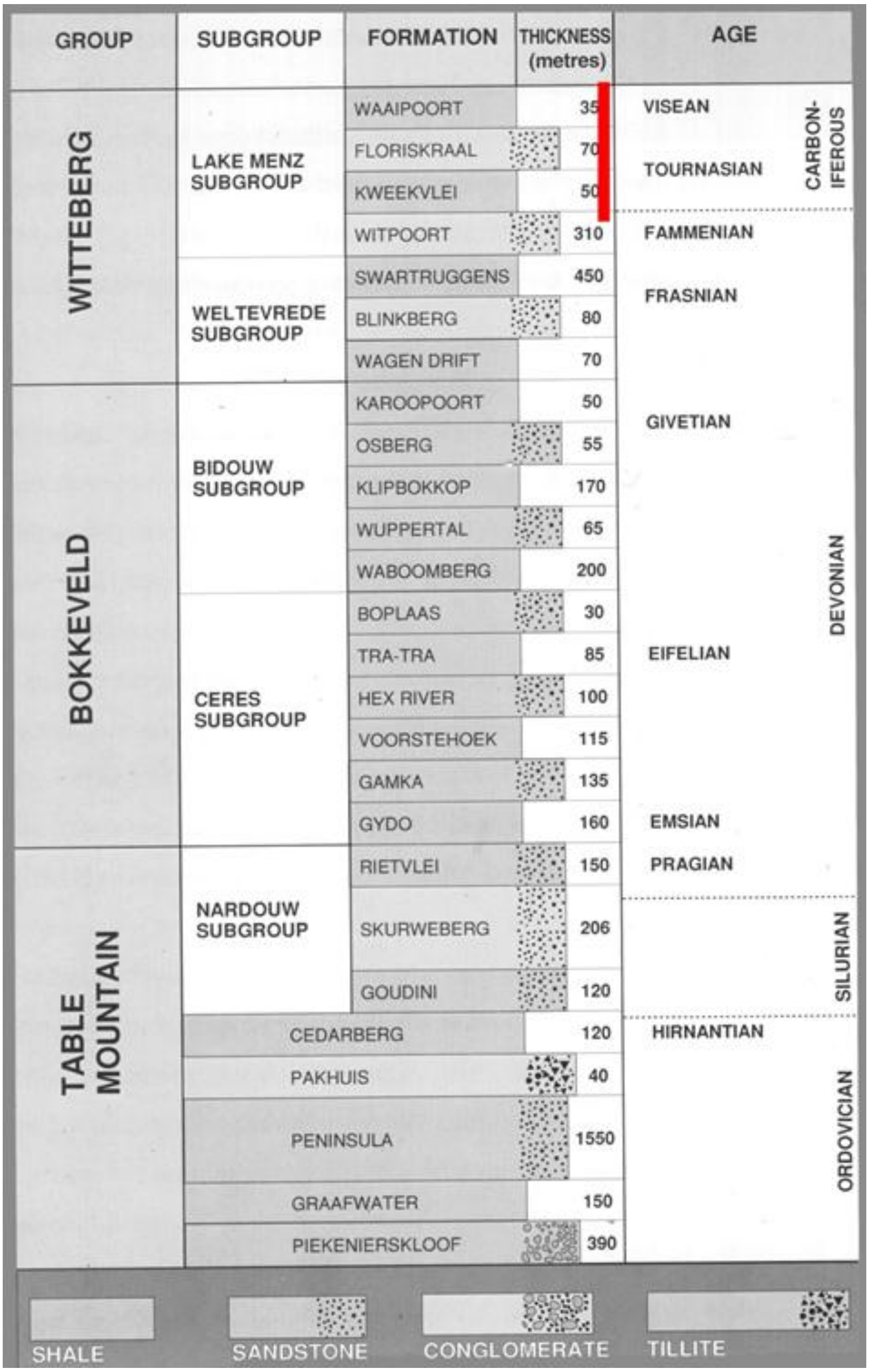

Figure 1: Stratigraphic column of the Cape Supergroup modified after Theron and Thamm (1990) following Cotter (2000). Red line indicates strata impacted by the development.

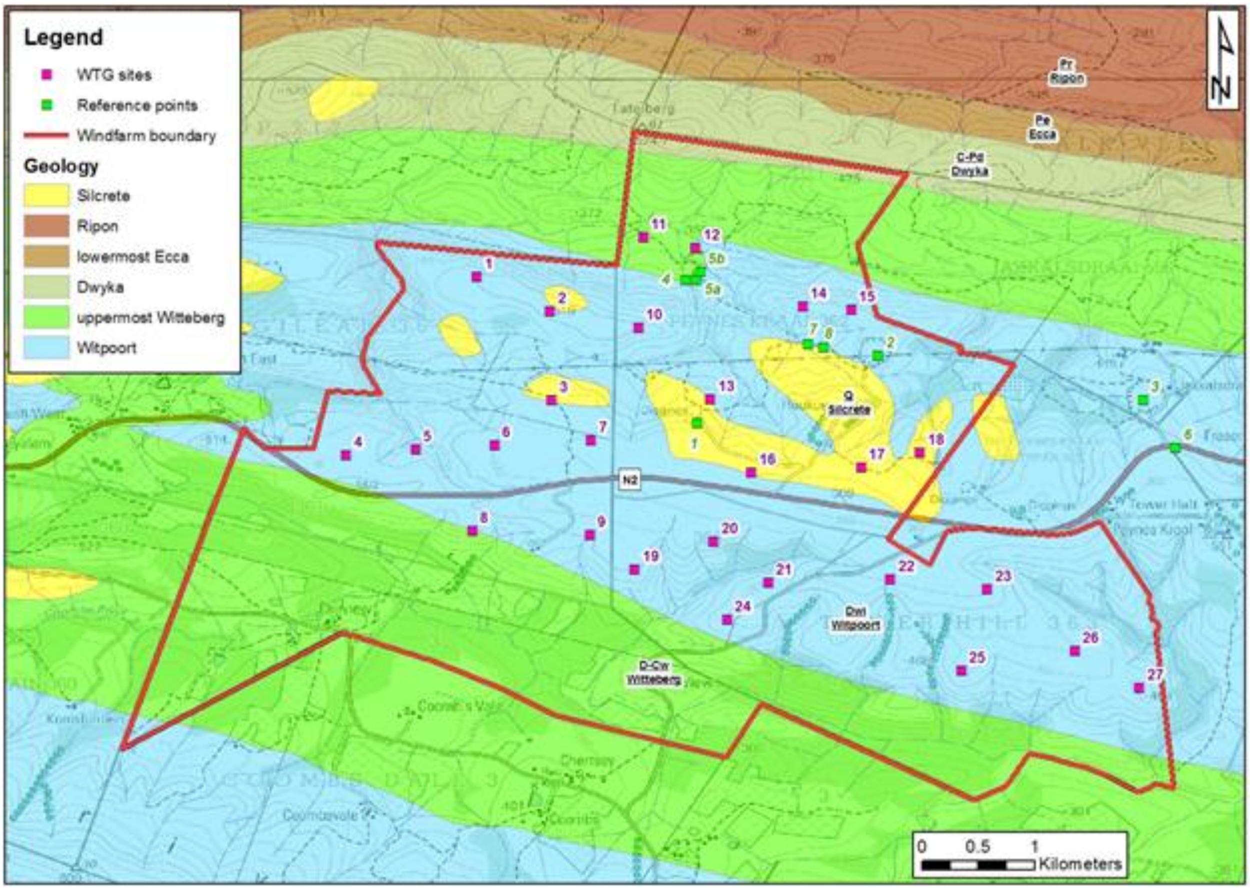

Figure 2. Geological map of the study area based on geological survey data overlain on topography, with positions of proposed wind towers marked as pink squares and points referred to in the text marked as green squares.

3 SITE VISIT

The proposed development area was surveyed with a vehicle and on foot, with particular attention being paid to those areas which will be affected by the development.

The development is to be situated on a series of quartzitic hills in the centre of the study area. These result from erosion of Witpoort Formation Witteberg quartzite strata upwardly folded in a large asymmetrical east-west trending anticline. Partial loss of the uppermost quartzitic strata, that once comprised the top of the fold arch, occurred during erosion of the Cretaceous to Tertiary African Surface. This exposed, towards the northern side of the fold, a thick horizon of black carbon-rich shaly mudstone interbedded within the upper Witpoort Formation. This black shale is stratigraphically equivalent to the black shales exposed at Waterloo Farm (30 kilometres to the east), which have proved the most important Late Devonian palaeontological site in Africa.

Unfortunately (from a palaeontological perspective), deep weathering of this carbonaceous shale, during the Tertiary, reduced the shale to a fine quality kaolin clay capped by silcrete of the Grahamstown Formation. Subsequent differential weathering of this soft clay led to the development of an east-west trending valley towards the north of the fold, hemmed in by quartzitic hills. Nonetheless significant deposits of clay remained along the sides of valley and where protected by remnants of silcrete. These deposits were utilised in precolonial times and a number of large quarries were exploited during the 20th century (Fig. 2. Points 1-3). One of these (Fig. 2. Points 2) appears to have begun as exploitation of a silcrete capped “sugarloaf hill” and continued downwards until weathered remains of the original black shale were encountered. Where exposed by the quarry these strata were carefully examined, during the survey, but no fossil material was located. Thin veins of fine red ochre were also seen in this quarry - identical to ochre pieces noted in a rock shelter adjacent to San rock art within the study area.

Figure 3. View eastwards from point 2 to point 3 (fig. 2) showing valley carved into kaolin.

Figure 4. Black Witpoort Formation clay underlying kaolin clay deposit at point 2 (fig.2).

Figure 5. Close up of black Witpoort Formation shales exposed at point 2 (fig. 2). Scale = 5 cm

Figure 6. Silcrete capping material of the Tertiary Grahamstown Formation discarded at point 2 (Fig. 2). Scale = 5cm.

The Witpoort Formation quartzites which stratigraphically overlie the black shales are well exposed in valleys and roadcuttings throughout the area but are weathered to smooth heath covered surfaces on many of the hill crests intended for the installation of turbines. Where they are well exposed they comprise stacked packages of cross bedded mature sandstones with shallow-water ripple surfaces (Fig. 7) and ropy horizontal trace fossils (Fig. 8).

Scale = 5cm

Figure 7. Shallow water ripples in uppermost Witpoort Formation quartzites at point 5a (fig. 2)

Figure 8. Horizontal invertebrate feeding traces in uppermost Witpoort Formation quartzites exposed at point 5b (fig.2)

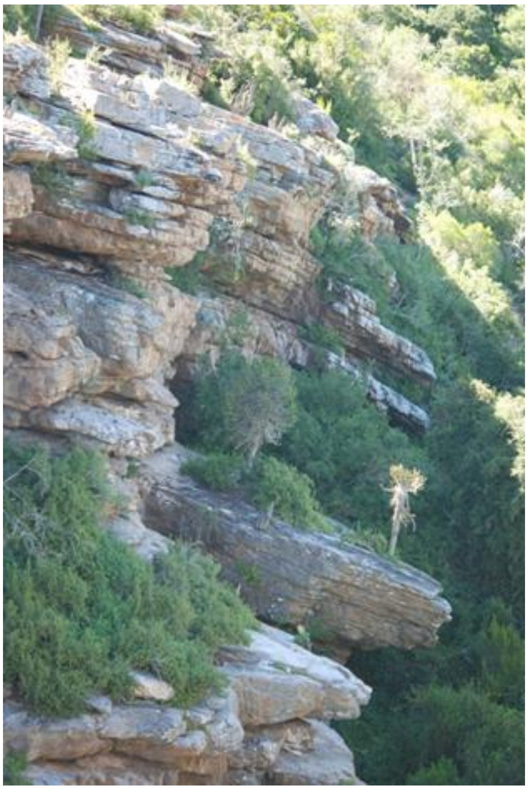

Figure 9. Stacked layers of Witpoort Formation quartzites at point 4 (fig. 2)

Figure 10. Trough cross bedding in Witpoort Formation quartzites at point 6 (fig. 2)

Figure 11. Shallow water ripples in Witpoort Formation quartzites at point 6 (fig. 2)

The Witpoort Formation is stratigraphically overlain by fine grained brown shales of the upper Lake Mentz Subgroup. These outcrop to the north and to the south of the quartzite ridge. On the south (sea facing) slopes, the high rainfall has reduced almost all outcrop to smooth, steep, vegetated slopes. To the north of the ridge the outcrop falls within a rainshadow caused by the ridge. Here the vegetation is more arid, the soil thinner and crumbly patches of outcrop may be found. The contact is more uneven than is indicated by the survey map and upper Lake Mentz Subgroup shales are found at points 7 and 8 (Fig. 2) (Figs 12-13)

Figure 12. Small road aggregate quarry in upper Lake Mentz Subgroup shale. Point 7 (fig. 2)

Scale = 3.5 cm

Figure 13. Plant fragments in upper Lake Mentz Subgroup shale. Point 8 (fig. 2)

Although plant fragments were noted in shale at point 8, they did not constitute a significant palaeosite.

Dwyka diamictite crops out in the extreme north of the study area which will not be affected by the development. It does not contain fossils.

4 CONCLUSIONS AND RECOMMENDATIONS.

It is the nature of palaeontological resources that important sites may be spatially very limited, yet they may prove to be of international significance. Discovery of such resources during development may be of great permanent benefit to the scientific community. Their destruction represents a severe permanent loss which may be of international significance.

The development area is focussed on Witpoort Formation quartzite ridges which were not, at surface, found to be significantly fossiliferous. Potentially important interbedded black shales within the quartzites are kaolinised to a deep depth. There is therefore only a low likelihood that palaeontological resources will be discovered/destroyed.

It is therefore recommended that:

1. Should any possible palaeontological material be disturbed during the development SAHRA should be immediately informed and a qualified palaeontologist appointed to investigate.
2. At the end of the initial construction phase, prior to rehabilitation a palaeontologist should survey all material excavated during installation of the towers and disturbed during construction of road and cable networks.