Palaeontological Impact Assessment for the Proposed Inyanda - Roodeplaat Wind Energy Facility

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Statement of Independence

I, Dr Robert W. Gess of Rob Gess consulting am a palaeontology PhD alumna of the Evolutionary Studies Institute of Wits University. I am an independent consultant and have no business, financial, personal or other interest in the proposed project, other than fair remuneration for work performed as a palaeontologist. There are no circumstances that compromise the objectivity of my performing such work.

Contents:

Background

Inyanda Energy Projects (PTY) Ltd, a renewable energy company, plans to develop a wind energy facility (or 'wind farm' to be named the Inyanda - Roodeplaat WEF) between the towns of Patensie and Kirkwood, within the Sundays River Valley Municipality, Eastern Cape Province, South Africa. According to Inyanda Energy, available wind data in South Africa shows this area to have favourable wind conditions sufficient to support a wind farm. This has been confirmed by on site wind monitoring that has been ongoing since June 2012. The proposed project area consists of approximately 12 200 ha located on 22 adjacent property portions.

The proposed Inyanda - Roodeplaat WEF will consist of approximately 48 to 55 turbines (depending on selected turbine) each capable of generating approximately 3 to 3.3 MW. The turbine footprints and associated facility infrastructure (internal access roads, substation, construction compound, batching plant and operations building) will potentially cover an area of approximately 60 ha depending on final layout design should the project proceed.

In accordance with the requirements of the NEMA 2010 EIA regulations the proposed project requires a full Scoping and EIA process to be conducted.

On behalf of the developers, SRK Consulting have subcontracted Rob Gess Consulting to conduct a Palaeontological Impact Assessment of the proposed project area and electricity line routes.

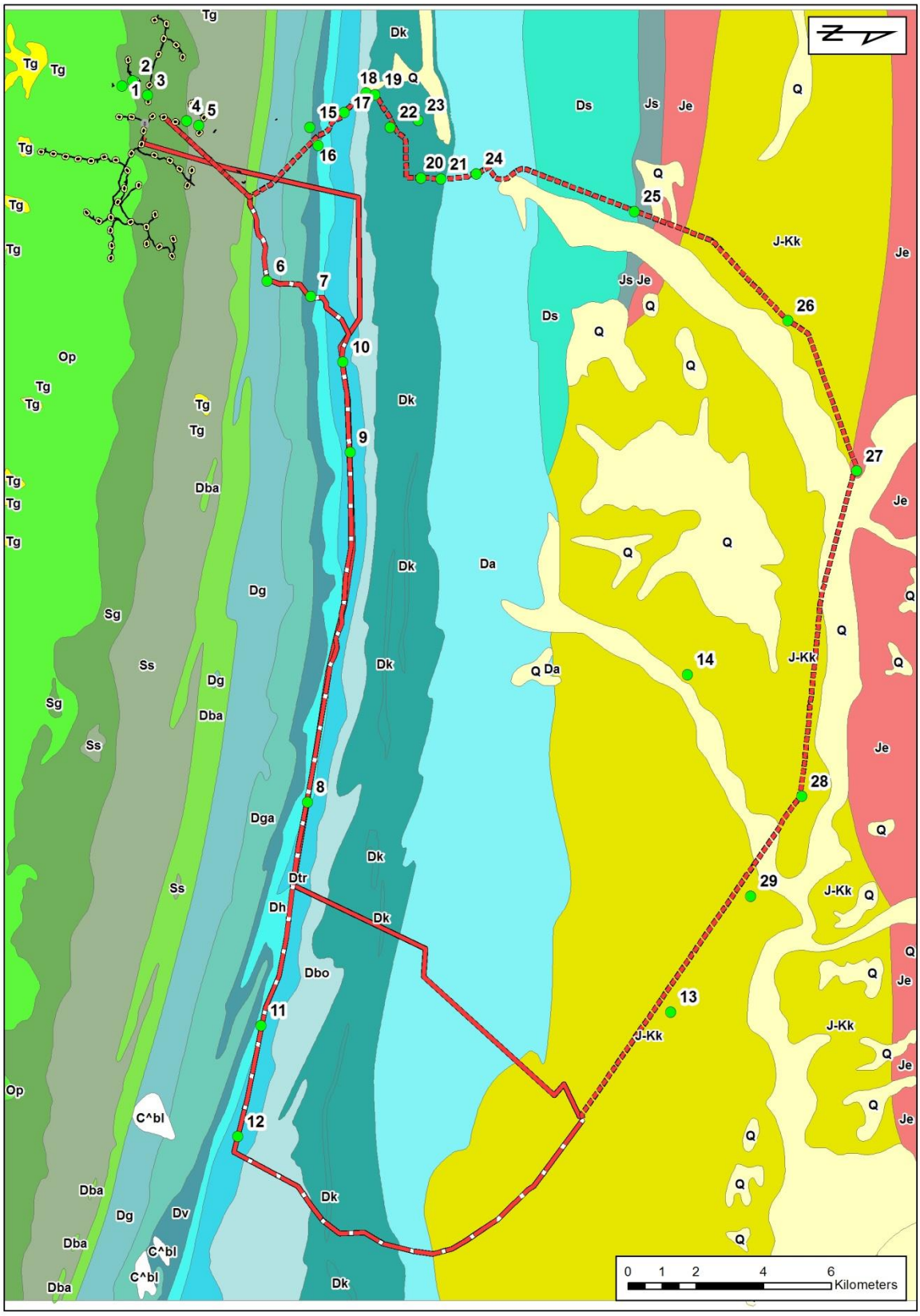
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Figure 1a: Map of development area with Geological Survey data and points of interest (see key below).

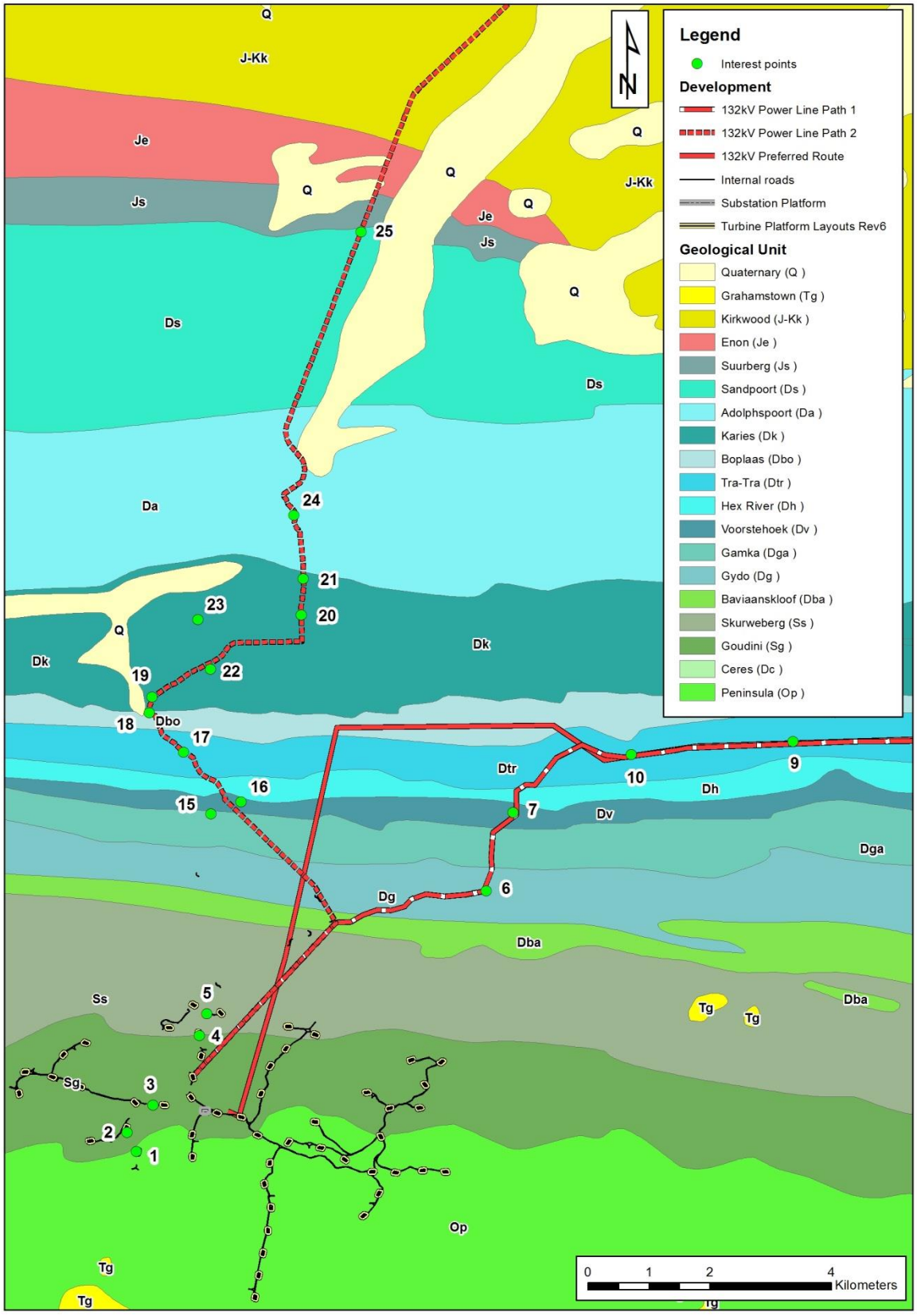

Figure 1b: Map of development area with Geological Survey data and points of interest – close up of south west portion of area.

Stratigraphy, Age, Origin and Palaeontology of Strata

Stratigraphy is the sequence of rock layers, from the lowest (oldest) to the highest (youngest). Conformably deposited rocks are ones which are continually deposited, layer upon layer, with only limited periods of disruption or erosion between them.

The wind turbine footprint area is situated over strata of the Ordivician to earliest Devonian Table Mountain Group (Cape Supergroup), whereas the proposed electrical pylon routes traverse strata representative of the entire early to mid Devonian Bokkeveld Group (Cape Supergroup), as well as the unconformably implaced volcanics and terrestrially deposited units of the Cretaceous Algoa Group.

Rocks of the Cape Supergroup 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.

The Table Mountain Group constitutes the first of three subdivisions of the Cape Supergroup. It consists of quartzitic sandstones derived from coarse sands deposited within the Agulhas Sea, and along its coastal plane. It was deposited during the Ordivician, Silurian and earliest Devonian Periods, approximately 500-400 million years ago.

The Bokkeveld Group, constituting the middle subdivision of the Cape Supergroup conformably overlies the Table Mountain Group. Bokkeveld strata consist largely of shales and thin interbedded sandstones derived from marine continental slope muds of early to mid Devonian (+/- 400 - 370 myo) age – which were deposited within the basin of the Agulhas Sea, during a phase of subsidence and deepening.

During the Carboniferous and early Permian periods rocks of the Cape Supergroup were folded into a series of immense east-west trending folds which comprise the Cape Fold Belt, stretching from near Fish River Mouth in the Eastern Cape to the Western Cape. Cape Supergroup strata in the study area are exposed in the northern arm of a large slightly overturned east-west trending anticline. Most units are, as a result, exposed in near vertical section with the oldest in the south of the study area and progressively younger strata towards the north. Coarser grained (metasandstones) occur as a series of parallel east-west trending ridges, whereas softer meta- shale and mudstone units have been carved into a series of intervening valleys which drain eastwards towards the Sundays River.

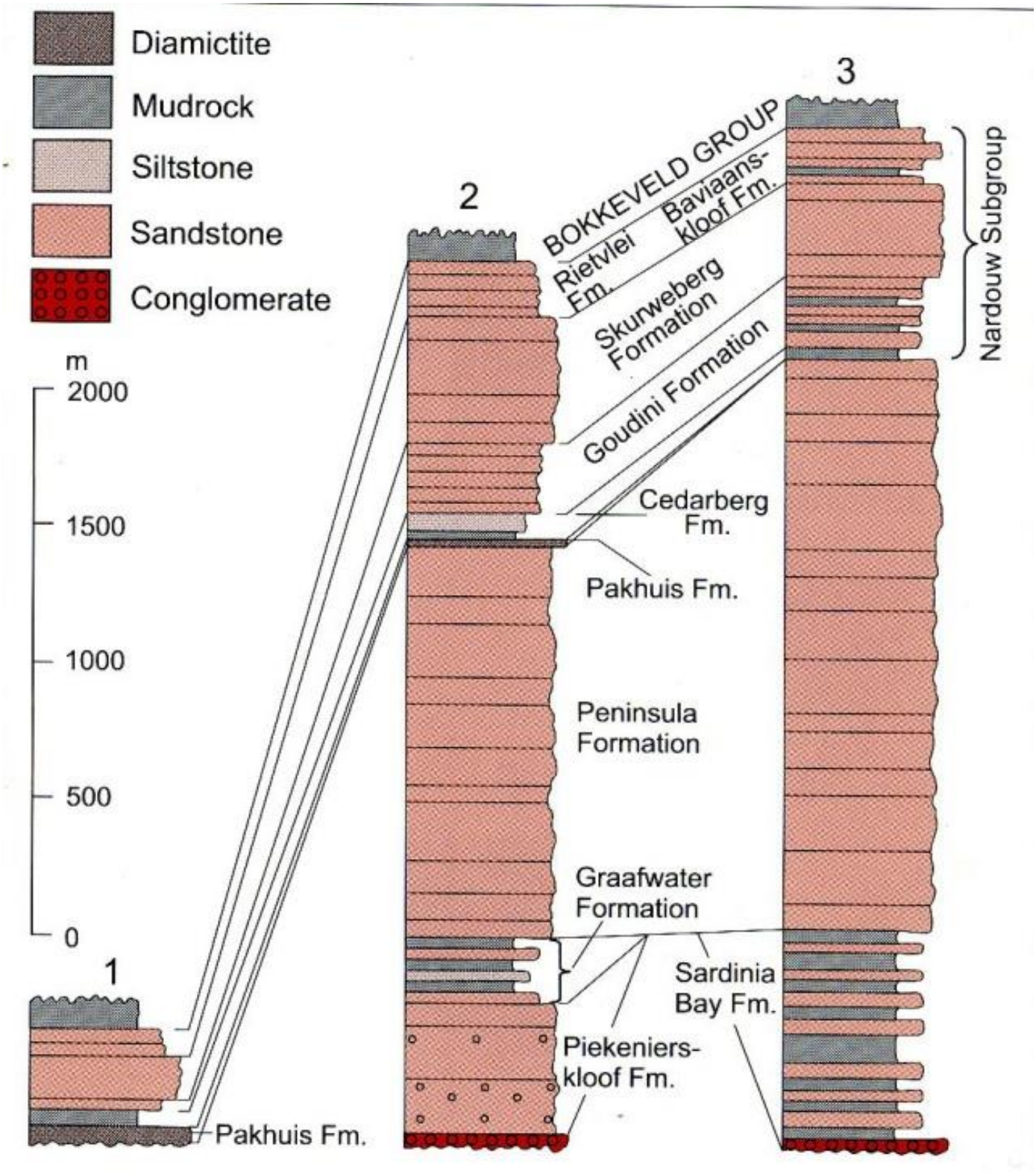

Fig. 2. Stratigraphy of the Table Mountain Group, 3 represents the Eastern Cape (Johnson *et al*., 1999)

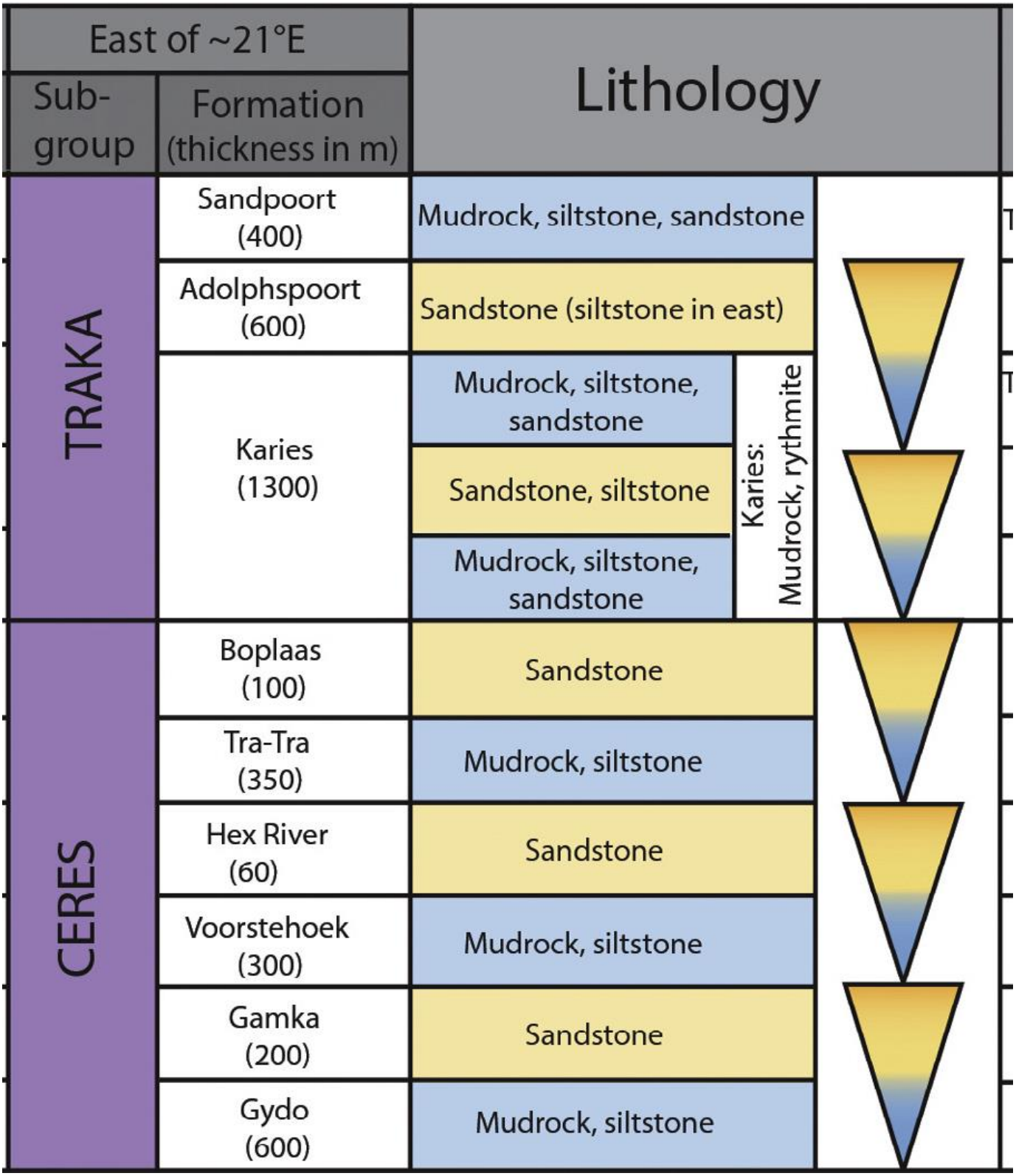

Figure 3: Stratigraphy of the Bokkeveld Group within the study area (redrawn by Reid *et al.* (2005) from Thamm and Johnson, 2006)

Very rare trace fossils have been recorded from the sandier units of the Table Mountain Group in the Western Cape, including the **Peninsular Formation**, which is the oldest (Ordivician) unit exposed within the study area. These trace fossils are associated with presumed marine incursions onto the coastal plane of the Agulhas Sea, on which riverine deposit of course sands resulted in the bulk of this unit.

More importantly, shale and mudstone interbeds within the Table Mountain Group are known to contain rare records of early Agulhas Sea life. Significantly the Soom and Disa shales, which comprise the **Cederberg Formation** provide an extremely valuable record of latest Ordivician life. The Soom shale exhibits soft tissue preservation, and has yielded specimens of primitive jawless fish, eurypterids, trilobites, orthocone nautiloids, brachiopods and molluscs. A brachiopod dominated invertebrate fauna has also been recorded from the somewhat sandier overlying Disa Formation. In addition to brachiopods this fauna includes trilobites, bryozoans, crinoids, tentaculitids and crustaceans. Due to poor outcrop, fossil faunas of this unit have not yet been uncovered in the Eastern Cape.

The **Baviaanskloof Formation**, uppermost unit of the Table Mountain Group has been recorded, particularly within the Klein Karroo (but more recently within the Eastern Cape), to contain concentrated lenses of invertebrate fossils which help to establish an earliest Devonian age for this Formation. They provide very early examples of the cold water marine Malvinokaffric invertebrate faunas that characterised the near polar Agulhas Sea during deposition of the Bokkeveld Group and its equivalents in south eastern South America. The Baviaanskloof Formation fossil record is dominated by brachiopods, but also includes the remains of trilobites, bivalves, gastropods and tentaculitids. Some burrow fills are also known. In addition South Africa's earliest described plant, *Dutoitia pulchra*, was collected from the middle portion of the Baviaanskloof Formation. Ongoing research in the Baviaanskloof Formation outcrops of the Eastern Cape is adding to our knowledge of Africa's earliest floras.

Bokkeveld Group strata are subdivided into a series of alternating mudstone and sandy units resulting from fluctuating depth in the Agulhas Sea. Sandy units represent outgrowth of the coastline during periods of reduced subsidence, whereas muddier units represent times of greater subsidence during which sandy coastlines were flooded and mantled by deeper marine muds. Lower units, are grouped together within the **Ceres Subgroup.** Mudstone units of this subgroup (the **Gydo**, **Voorstehoek** and to a lesser extent **Tra-Tra** Formations) have yielded abundant fossil evidence of a range of early to mid Devonian deep water invertebrate faunas. These were comprised of diverse brachiopods, molluscs, echinoderms and trilobites. In addition a few very localised but exciting fish fossils have been described. Plants and trace fossils are also known. Most research on these units has been conducted in the Western Cape with only a few sites having been studied in the Eastern Cape. The most important Gydo Formation locality in the Eastern Cape is, however, situated only a short distance to the south west of the study area, where abundant invertebrate fossils have been collected preserved within early diagenetic nodules.

The intervening sandy units of the Ceres Subgroup (the **Gamka**, **Hexriver** and **Boplaas** Formations) are far less fossiliferous, though they are also known to contain Agulhas Sea invertebrate assemblages in the form of presumed storm accumulations. These are rare within the Boplaas formation which, in the west of the country is characterised by bedding planes of transported plant fragments.

Invertebrate assemblages are far scarcer in the formations of the overlying **Traka Subgroup**, the **Karies**, **Adolphspoort** and **Sandpoort** Formations, which represent more near shore deposits. Importantly though strata of the **Adolphspoort** Formation in the Klein Karoo have yielded extremely important mid Devonian chondrichthyan and placoderm fish fossils, in addition to plant and bivalve remains.

Far more recently, during the Cretaceous (142 to 65 million years ago) post-dating the lithification, folding and uplift of the Cape Supergroup strata, a number of fault systems (resulting from the eventual breakup of the supercontinent Gondwana), opened along the coastline of southern Africa. Slow downward collapse of large chunks of continental margin resulted in the formation of a number of shear sided basins along the coast. Those of the Algoa Basin were filled with sediments that became the semi consolidated strata of the **Uitenhage Group**. Strata assigned to the **Enon** and **Kirkwood Formations** of the Uitenhage Group underlie the northern part of the study area.

To the north of the **Sandrift and Adolphspoort Formations** (Bokkeveld Group, Cape Supergroup) a thin rim of Cretaceous volcanic of the **Suurberg Group** (**Uitenhage Group**) in places mark the edge of Cretaceous fault scarp. These are however often poorly exposed due to weathering. Like most volcanic rocks they are considered devoid of fossils.

To the north of the palaeo scarp line occur terrestrially derived sediments of the Uitenhage Group. To the west, conglomerates of the Enon Formation are encountered before those of the Kirkwood Formation, whereas more easterly the Kirkwood Formation is exposed immediately adjacent to the Cape Supergroup strata comprising the scarp.

The **Enon Formation** (**Uitenhage Group**) consists of coarse pebbly conglomerates formed in close proximity to the fault scarp, where mountain valleys disgorged their contents into the basin. Often further from the fault scarp rivers meandering across the coastal plain towards the sea deposited the muddy sands that gave rise to the **Kirkwood Formation** (**Uitenhage Group**). A third formation deposited in the Algoa Basin, but which is not represented within the study area, is the Sundays River Formation (Uitenhage Group). This was simultaneously deposited within a marine setting.

The Enon Formation is generally unfossiliferous however the Kirkwood Formation is South Africa's primary source of Cretaceous Dinosaur fossils. It was in Kirkwood Formation rocks, on the banks of the Bushman's River that South Africa's first dinosaur discovery was made in 1845 by William Atherstone and his wife. Originally dubbed "Cape Iguanadon" the fragmentary remains have, more recently been shown to be those of a *Stegosaurus*. Remains of two types of Sauropod Dinosaur, as well as a Theropod Dinosaur and an Ornithopod Dinosoar have subsequently been collected from Kirkwood Formation strata at various

localities. Recent research has also revealed the remains of a primitive lizard, a type of crocodile and a primitive early mammal. These remains are sometimes found in association with fossil logs and chunks of fossil wood, which are fairly common in Kirkwood Formation rocks. Associated mudstones have yielded a range of finely preserved plant leaves and fructifications, including those of a number of species of ferns, cycads and conifers

Site visit

The proposed wind energy facility area and possible powercable routes were surveyed by Rob Gess Consulting between the 2nd and 6th of June 2015.

Wind Tower Positions: The facility itself is to be constructed along a high ridge comprised largely of vertically tilted, fairly massive quartzites of the **Peninsular**, **Goudini** and **Skurweberg** Formations. The Geological Survey did not map the Cedarberg Formation as a separate unit due to difficulties in identifying it in the field. Nonetheless a very slight step cutting the spurs at the base of the Goudini Formation is suggestive thereof. Due to weathering and fynbos cover it was difficult to find fresh outcrop to evaluate. Near surface outcrop of these units was however sporadically available where the road system into the mountains had been recently cut back and upgraded. Mudstone units observed near the contact between the Peninsular and Nardouw Formations may belong to the Cedarberg Formation.

Figure 4: View of Peninsular Formation strata (near point 1) along ridge intended for wind tower.

Figure 5: View towards point 2, mapped as the basal part of the Nardouw Formation.

Figure 6: Mudstone units near the base of the mapped Nardouw Formation that may represent the Cedarberg Formation.

Figure 7: View west from point 3 showing ridge of Goudini Formation strata along which westernmost wind towers are proposed.

Figure 8: Overturned strata of the uppermost Goudini Formation at point 4.

Figure 9: Quartzitic sandstones of the Skurweberg Formation exposed at point 5.

No wind towers are envisaged to be situated on the Baviaanskloof Formation. It is likely that the quartzitic strata of the Peninsular, Nardouw and Skurweberg Formations will not impact palaeontologically important material. This said mudstones exposed in the vicinity of the

contact between the Peninsular and Nardouw Formations, which probably belong to the Cedarberg Formation, may well be of palaeontological importance. At least 6 wind turbines follow this horizon and excavation of deep foundation holes for them is likely to expose fresh mudstone and shaly material that may be of palaeontological significance.

Pylon Routes

Proposed possible pylon routes initially cross strata of the **Nardouw**, **Skurweberg** and **Baviaanskloof Formations** of the **Table Mountain Group** (Cape Supergroup). Although the Nardouw and Skurweberg Formations are considered unlikely to be sensitive in this regard, the **Baviaanskloof Formation** may be, though it was not possible to adequately assess it at this point due to it being weathered and buried beneath scree.

From this point, two routes, a more southerly "southern route" and a more northerly "northern route" have been proposed and were assessed.

"Southern Pylon Route"

The southern proposed pylon route was examined and all available outcrops assessed. In the east, where the routes cut northwards across farmland, to join the northern route it was not possible to directly asses the route as access details were not available to the palaeontologist and farm gates were locked.

After passing over the Table Mountain Group strata comprising the mountains, the southern route cuts through lower Bokkeveld Group strata. Tor the initial few kilometres two possibilities have been proposed (see figure 1). One of these cuts across private land that was inaccessible. The other follows the route of a small road. This latter route was systematically investigated. It initially traverses a valley carved out of mudstones of the **Gydo Formation (Bokkeveld roup)**. These mudstones are well exposed in a small road quarry at point 6 (figure 1). This quarry appears to be being used to upgrade roads on the property. Sparse brachiopods fossils and an unidentified fossil were noted here. (Fig. 10).

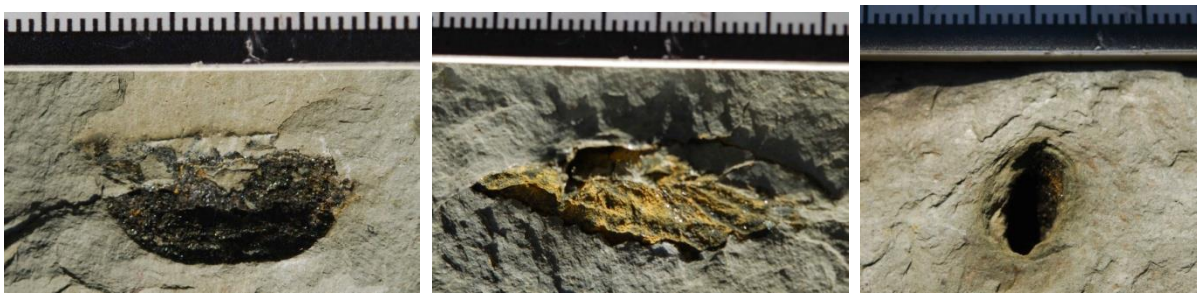

Figure 10: Brachiopod fossils (left) and an unidentified fossil (right) observed in mudstones of the Gydo Formation exposed in a small quarry at point 6 (fig.1).

Thereafter this route cuts northwards across the vertically inclined **Gamka**, **Voorstehoek** and **Hexriver Formations** of the **Bokkeveld Group**, before entering a long valley comprised of

Tra tra Formation (Bokkeveld Group) mudstones. The **Gamka** and **Hexriver** Formations are sandstone dominated units that form east-west trending ridges and were not found to be visibly palaeontologically sensitive.

A quarry between these ridges (point 7, Fig.1), in a valley excavated from mudstones of the **Voorstehoek Formation (Bokkeveld Group)** however proved to be exceptionally fossiliferous. This quarry, which lies along the proposed pylon route appears to be being actively mined to provide aggregate for maintaining and upgrading the main route to the site. It was found to be rich in fossils representing moults of the trilobite *Burmeisteria,* crinoids, orthocone nautiloids, bivalves, tentaculitids and a variety of brachiopods including *Schuchertella*, *Australospirifer,* and number of chonetids. This site is of extreme importance as it represents one of only three productive sites of this age in the eastern Eastern Cape.

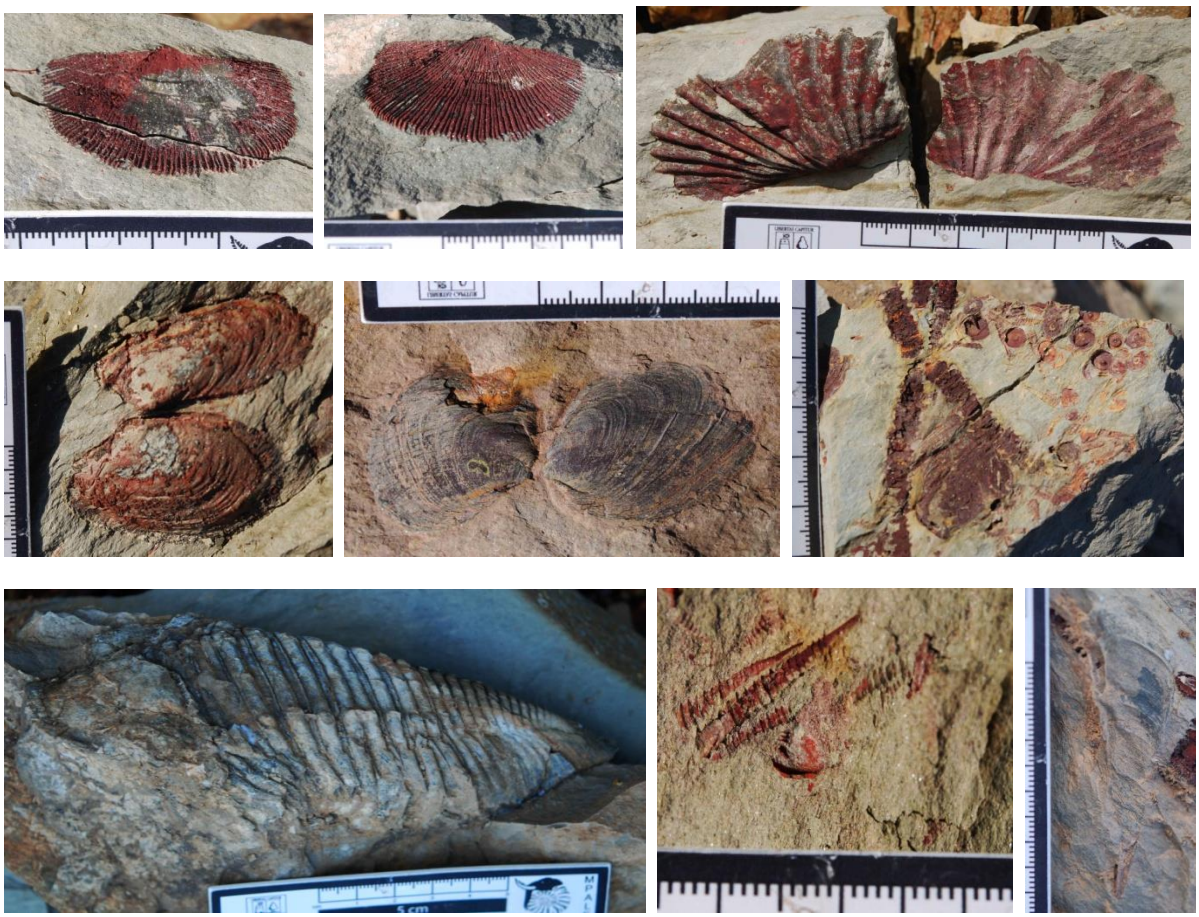

Figure 11: Devonian marine invertebrate fossils of the Voorstehoek Formation (Bokkeveld Group) from the borrow pit at point 7 (Fig.1); top row: brachiopods, *Schuchertella* in part and counterpart (*left & middle*) and *Australospirifer* (right); middle row: bivalves (*left & middle*), crinoid (echinoderm) stalks (*right*); bottom row: *Burmeisteria* (trilobite) (*left*), tentaculitids (*middle*) and orthocone nautiloid (*right*).

North of the ridge formed by the sandstone rich Hexriver Formation (Bokkeveld Group, Cape Supergroup) the proposed pylon route turns eastward and follows an east-west valley for approximately 20 km. This valley is carved by an east draining watercourse from green,tan and purplish mudstones and sandy mudstones of the **Tra Tra Formation** (**Bokkeveld Group**, **Cape Supergroup**) Reddish mudballs are common. Outcrop is generally mantled by a thin soil cover, but where exposed it proved moderately fossiliferous. Invertebrate fossils were particularly noted at point 10 (fig. 1), where bioturbation of mudstones was also evident. The pylon route is largely situated across strata of the Tra Tra Formation but also briefly impinges on strata of the Hex River Formation (see fig.1).

Figure 12: View of southern pylon route traverse through valley carved from Tra-Tra Formation, looking westwards from point 12.

Figure 13: Vertically tilted stratigraphic top of the Hex River Formation exposed at point 11.

Figure14: Detail showing surface of small ripples marking the top of the Hex River Formation at point 11.

Figure 15: (*top left*) Outcrop of Tra-Tra Formation at point 8 (Fig. 1); (*top right*) bioturbation of sediments observed at point 8; (*bottom left*) orbicular brachiopod; (*bottom middle*) trilobite fragments, (*bottom right*) fragments of crinoids stem.

Figure 16: (*left*), Horizontal invertebrate the Tra-Tra Formation at point 9 (Fig. 1); (*right*), fragment of orbicular brachiopod from near the base of the Tra-Tra Formation at point 8 (Fig. 1).

Two possible routes have been suggested by which the southern route could cut northwards across to the substation at point 13 (Figure 1), adjacent to the R75. It was not possible to fully assess either of these routes as access to fenced game farm areas was not obtained. Both of these routes cut over hills of the Boplaas Formation, across a valley of the Karies Formation, and over hills of the Adolphspoort Formation before crossing a wide plain of weathered Kirkwood Formation *en route* to the substation. The more easterly of these routes for some while runs parallel to the R75. It was noted that, along this stretch, there was not much outcrop of the Kirkwood Formation, which was deeply weathered. The same was noted immediately to the south of the substation along the alternate route.

Figure 17: View eastwards along eastern approach to substation (point 13, Fig.1) for "southern route". Alluvial surface generated from weathered Kirkwood Formation.

Figure 18: View southwards along alternate southern approach to substation (point 13, Fig.1) for "southern route". Reddish alluvium from weathered Kirkward Formation in foregrpound. Hills comprised of Adolphspoort formation strata in the background.

Due to lack of access to these last two route components an alternate transect across the plain was explored along the Krompoort road in order to assess the nature of Kirkwood Formation strata crossing the plain (vlakte). Although the Kirkwood Formation was fairly uniformly concealed by alluvial cover, it was not deeply buried and small outcrops were evident. These were particularly associated with relict outcrops of more resilient greenish sandy subunits. One of those examined (at point 14, fig.1) was found to contain abundant Cretaceous Fossil logs including a permineralised specimen. In addition a fragment of dinosaur bone was noted, possibly a fragment of a Stegosaur back plate.

Figure 19: Cretaceous fossil remains at point 14 (Fig.1); (*left*) permineralised tree log; (*right*) Dinosaur bone fragment.

“Northern Pylon Route”

As this pylon route exclusively followed the route of a number of roads and minor roads it was possible to entirely survey it. It initially cuts more directly northwards across all locally occurring units of the Bokkeveld Group, in addition to most units of the Uitenhage Group. Thereafter it follows the main road eastwards across weathered Kirkwood Formation strata, to the substation.

Most shale and mudstone derived units along this route are not well exposed and may only be found outcropping in borrowpits, riverbeds and roadcuttings. It is, however clear that they are only shallowly buried beneath recent alluvium, and will be exposed by any excavation for pylon footings.

More sandstone rich units stand out as ridges and are well exposed, however they were not seen to be richly fossiliferous. Most prominently these include the Adolphspoort Formation, the type locality of which is the Adolphspoort encountered along this route.

Figure 20: Gamka Formation composing a range of hill at point 15.

Figure 21: Voorstehoek Formation mudstones and sandstones exposed adjacent to a stream bed at point 16.

Figure 22: Tra-Tra Formation mudstones exposed in a small borrowpit at point 17.

Figure 23: Boplaas Formation outcrop at point 18, viewed from the north.

Figure 24: Boplaas Formation strata at point 18.

Figure 25: Vertical invertebrate burrow preserved in Boplaas Formation sandstone at pt. 18.

Figure 26: View south across valley excavated from Karies Formation mudstones from point 21(Fig.1) . Low hill in middle distance comprised of sandstone interbed within the Karies Formation. Hills behind represent Hex River Formation sandstones. Mountains in background represent Table Mountain Group strata.

Figure 27: Mudstones of the Karies Formation exposed in a borrowpit at point 20 (Fig.1). water ripple marks are evident on surfave facing viewer.

Figure 28: Hill comprised of sandstone interbeds within the Karies Formation at point 22 (Fig.1)

Figure 29: Mudstones of the Karies Formation underlying sandstones at point 22 (Fig.1), exhibiting red mudclasts.

Figure 30: Vertically tilted sandstone layers of the Adolphspoort Formation, within the Adolphspoort type locality (point 24, Fig. 1), exhibiting water ripples.

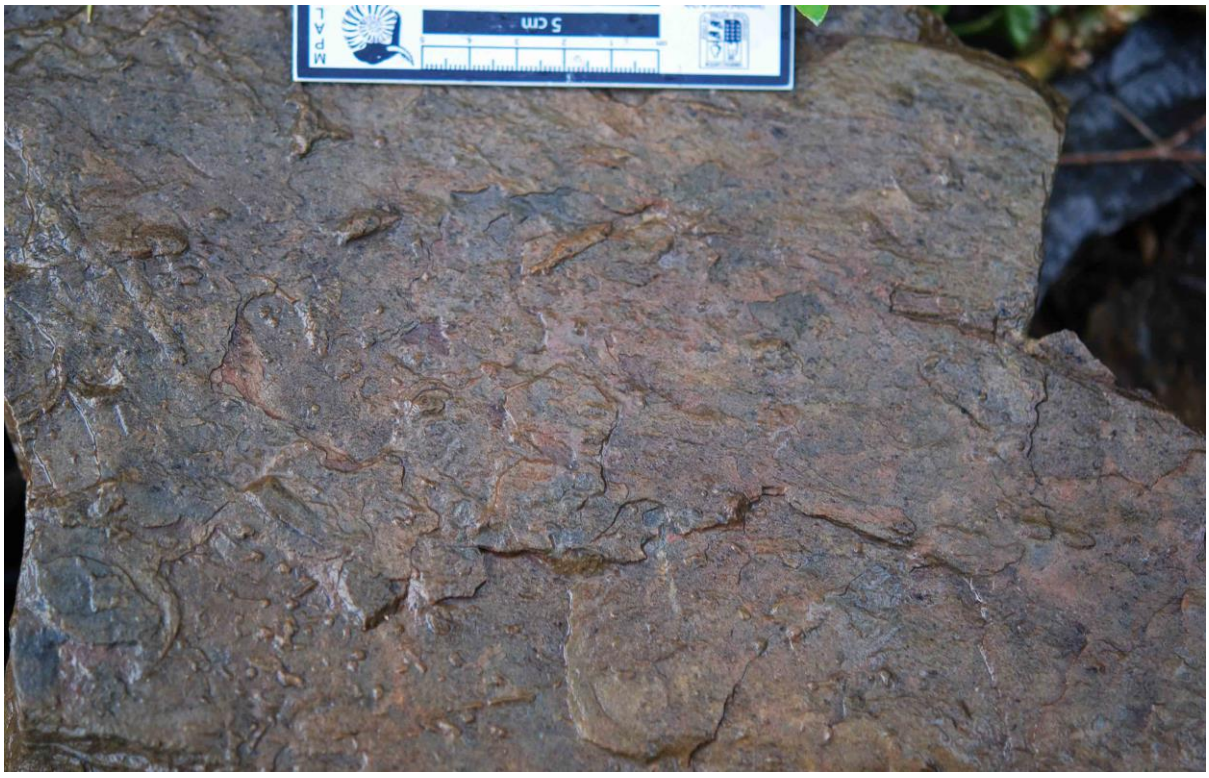

Figure 31: Invertebrate trace fossils within Adolphspoort formation strata, within the Adolphspoort.

Figure 32: Thinly bedded layers of mudstone and sandstone of the Sandpoort Formation exposed in a road cutting at point 25 (Fig.1)

Figure 33: Horizontal invertebrate trace fossil in sandstone interbed at point 25 (Fig.1).

Figure 34: Pinkish and greenish Cretaceous mudstones of the Kirkwood Formation exposed in a roadcutting at point 26 (Fig.1).

Figure 35: View eastward along pylon route from point 27 (Fig.1). Recent alluvium underlies the route in the foreground.

Figure 36: View looking eastwards, along pylon route across plain of weathered Kirkwood Formation, from point 28.

Figure 37: View looking westwards along pylon route from point 29 (Fig.1), across plain of weathered Kirkwood Formation.

Plant Storage, Control Area, Staff Accommodation and Turbine Site Laydown Area

The Plant storage, Control Area and Staff Accommodation areas are situated adjacent to each other (point 23, fig.1), whereas the proposed Turbine Site Laydown area is situated at a short distance away (point 22, fig. 1), all overlying strata of the **Karies Formation** (**Bokkeveld Group, Cape Supergroup**). Both are situated on areas mantled with thick recent alluvium and scree. As deep excavation is not expected in these areas, palaeontological resources are unlikely to be disturbed.

Figure 38: View of Turbine Laydown Area (Fig.1, point 22).

Figure 39: Accommodation, storage and office area (Fig. 1, point 23)

Conclusions and Recommendations

1) Wind tower positions are largely situated on strata of the Peninsular and Goudini Formation of the Table Mountain Group (Cape Supergroup), which are unlikely to be palaeontologically sensitive

2) About 6 wind tower positions are, however, probably situated on the Cedarberg Formation of the Table Mountain Group (Cape Supergroup). Due to the negatively weathering profile of this unit the Geological Survey did not map it along the southern mountain side where it is obscured by scree of the Goudini Formation. Excavations for **Pylon positions situated close to the contact (line on map) between the Peninsular and Goudini Formations are moderately likely to disturb highly sensitive Cedarberg Formation shales. A palaeontologist should be appointed to check these excavations before they are filled**.

3) The Control Office, Campsite, Plant Storage, Staff Accomodation and Turbine Layout areas are situated on thick alluvium mantling the Karies Formation. These are unlikely to disturb palaeontologically sensitive strata.

4) The pylon route will traverse the entire package of Bokkeveld group strata, as well as the Kirkwood Formation. As discussed above all these units are potentially fossiliferous. The ECO and contactors should therefore be diligent in looking out for palaeontological material where pylon footings are excavated and should report any observed fossils to a professional palaeontologist. There is a low chance that Kirkwood Formation dinosaur remains will be disturbed, but they would be of high importance. There is a medium chance that Bokkeveld fossils will be disturbed and these would be of moderate to high significance.

5) **A palaeontologist should be appointed by the developerto inspect all pylon holes excavated into the Voorstehoek Formation strata (see figure 1) which seems to be locally very fossiliferous**. T**here is a high chance that palaeontological material will be disturbed that is likely to be of medium to high significance.**

6) A palaeontologist should be appointed by the developer to inspect pylon holes in the vicinity of point 8 (Figure 1), where the Tra-Tra Formation is locally unusually fossiliferous. There is a low to moderate chance that palaeontological material would be disturbed here. This would be of moderate importance.

7) Of highest priority, the borrowpit (into mudstones of the Voorstehoek Formation) at point 7 (Figure 1), is of great palaeontological interest, providing one of only 3 comprehensive sites of this age in the eastern Eastern Cape. It appears likely that this borrowpit will be expanded to provide road aggregate for access roads for this development. It is certain that this borrowpit will disturb palaeontological material of high significance.This is acceptable as it will help to reveal palaeontological material for study. A palaeontologist should however be appointed by the developer to carry out fortnightly sampling of this borrowpit during the period of its utilisation.

Select Bibliography

Almond, J.E. 2008b. Palaeozoic fossil record of the Clanwilliam sheet area (1: 250 000 geological sheet 3218). Unpublished report for the Council for Gesocience, Pretoria, 49 pp.

Broquet, C.A.M. 1992. The sedimentary record of the Cape Supergroup: a review. In: DeWit, M.J. & Ransome, I.G. (Eds.) Inversion tectonics of the Cape Fold Belt, Karoo and Cretaceous Basins of Southern Africa, pp. 159-183. Balkema, Rotterdam.

De Beer, C.H. 2002. The stratigraphy, lithology and structure of the Table Mountain Group. In: Pietersen, K. & Parsons, R. (Eds.) A synthesis of the hydrogeology of the Table Mountain Group – formation of a research strategy. Water Research Comm. Rep. No. TT 158/01: pp.9-18.

Hiller, N. 1992. The Ordovician System in South Africa: a review. In Webby, B.D. & Laurie, J.R. (Eds.) Global perspectives on Ordovician geology, pp 473-485. Balkema, Rotterdam.

Le Roux, F.G. 1989. The lithostratigraphy of the Cenozoic deposits along the South-EasternCape coast as related to sea-level changes. *MSc Thesis, Stellenbosch University*. 247p.

Johnson, M.R., Theron, J.N. and Rust, I.C. 1999. Table Mountain Group. South AfricanCommittee for Stratigraphy, Catalogue of South African Lithostratigraphic Units 6: 43-45.Council for Geoscience, Pretoria.

MacRae, C. 1999. Life Etched in Stone: Fossils of South Africa. The Geological Society of SA, Johannesburg. 305p.

Malan, J.A. and Theron, J.N. 1989. Nardouw Subgroup. Catalogue of South African lithostratigraphic units, 2 pp. Council for Geoscience, Pretoria.

McCarthy, T. and Rubidge B.S. 2005. The sotry of Earth & Life; a southern Africanperspective on a 4.6 billion-year journey. Struik publishers, Cape Town. 335p.

Partridge, T.C. and Maud R.R. 1987. Geomorphic evolution of southern Africa since theMesozoic. *S. Afr. J. Geol*. 90(2): 179 – 208.

Reid, M., Bordy, E. and Taylor W. (2015) Taphonomy and sedimentology of an echinoderm obrution bed in the Lower Devonian Voorstehoek Formation (Bokkeveld Group, Cape Supergroup) of South Africa. *Journal of African Earth Sciences* 110: 135-149.

Rust, I.C. 1967. On the sedimentation of the Table Mountain Group in the Western Capeprovince. Unpublished PhD thesis, University of Stellenbosch, South Africa, 110 pp.South African Committee for Stratigraphy (SACS). 1980. Stratigraphy of South Africa, Part 1

(Comp. By L.E. Kent). Lithostratigraphy of the Republic of S. A., S. W. A./Namibia, and the Republics of Bophutatswana, Transkei and Venda. Handbook Geol.Surv. S.Afr., 8.

Tankard, A., Welsink, H., Aukes, P., Newton, R. and Stettler, E. 2009. Tectonic evolution ofthe Cape and Karoo Basins of South Africa. Marine and Petroleum Geology 3, 1-35.

Thamm, A.G. and Johnson, M.R. 2006. The Cape Supergroup. In: Johnson, M.R.,Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 443-459.Geological Society of South Africa, Marshalltown.