Palaeontological Heritage Input: combined field-based & desktop study

PROPOSED KUDU & TANGO WIND ENERGY FACILITIES NEAR ABERDEEN, SARAH BAARTMAN DISTRICT, EASTERN CAPE PROVINCE

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EXECUTIVE SUMMARY

FE Kudu (Pty) Ltd is proposing to develop two wind energy facilities (WEFs) and associated infrastructure – to be known as the Kudu WEF and Tango WEF - on separate sites located approximately 20 to 40km west of Aberdeen, Sarah Baartman District Municipality (Dr Beyers Naude Local Municipality) in the Eastern Cape Province.

The Kudu WEF and Tango WEF project areas on the northern margins of the Aberdeen *Vlaktes* are underlain at depth by potentially fossiliferous continental (fluvial / lacustrine) bedrocks of the Lower Beaufort Group (Adelaide Subgroup). These bedrocks probably belong largely or entirely to the Middle Permian Abrahamskraal Formation rather than the Late Permian Teekloof Formation as currently mapped. However, basal channel sandstones of the Poortjie Member (Teekloof Formation) might extend into the NW edges of the Kudu WEF project area on the lower footslopes of the Oorlogspoortberge. There are no historical records of fossil vertebrates from the two project areas; this is probably largely due to the extremely poor levels of bedrock exposure found here. Fragmentary remains of large dinocephalians have recently been recorded from the Aberdeen *Vlaktes* just to the south as well as from the slopes of the Oorlogskloofberge to the west. During the recent 3-day palaeontological field visit no occurrences of fossil vertebrates were recorded.

A background scatter of petrified (silicified) wood blocks reworked from the Lower Beaufort Group bedrocks occurs within surface gravels of eluvial and alluvial origin in several sectors of the Kudu WEF project area. Locally abundant, ferruginised moulds and poorly-preserved petrified wood occurs in association with channel sandstone basal conglomerates on the NW margins of the Kudu WEF project area (Oorlogspoortberge eastern footslopes). Most of the fossil wood material is poorly preserved and of very limited scientific value. Only one, fairly well-preserved block of Palaeozoic petrified wood, was recorded within the Tango project area. Mitigation of the recorded fossil wood sites is not recommended here, given the abundance and widespread occurrence of better-preserved material regionally in the northern Aberdeen *vlaktes* and the fact that the material is not *in situ*.

Most of the low-relief terrain within the WEF project areas is covered by a thin to thick blanket of Late Caenozoic superficial deposits, including alluvial gravels and sands, eluvial and colluvial surface gravels, calcrete hard pans, pan sediments and gravelly to sandy soils. Apart from reworked fossil wood blocks and Late Caenozoic calcretised plant root casts of widespread

occurrence and limited palaeontological interest, no fossils of Caenozoic age have been recorded within these younger sediments.

Given the rarity of significant vertebrate and other fossil finds and the very low surface exposure levels of Lower Beaufort Group bedrocks within the Kudu WEF and Tango WEF project areas due to the widespread alluvial cover, the overall palaeosensitivity of both project areas is assessed as LOW. The provisional Medium to Very High Palaeosensitivity mapped here by the DFFE Screening Tool is accordingly *contested*. The potential for occasional fossil vertebrate sites of Very High palaeosensitivity cannot be entirely excluded, however. The distribution of such sites is largely unpredictable and they are best mitigated through a Chance Fossil Finds protocol.

The impact significance of the proposed Kudu WEF and Tango WEF developments on local palaeontological heritage resources is assessed as LOW. The projects are not fatally flawed and there are no objections on palaeontological heritage grounds to their authorization. This assessment applies equally to all infrastructure components and layout options currently under consideration. Pending the discovery of new fossil sites in the Pre-Construction or Construction Phase, micro-siting of infrastructure (*e.g.* wind turbines, access roads) in relation to known fossil sites is not considered necessary.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Kudu WEF and Tango WEF developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by the ECO/ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds such as vertebrate bones, teeth and well-preserved petrified logs should be safeguarded and reported at the earliest opportunity to the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a fossil collection permit from ECPHRA. Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013). These recommendations must be included in the EMPr for the proposed renewable energy developments.

1. PROJECT OUTLINE & BRIEF

FE Kudu (Pty) Ltd is proposing to develop two wind energy facilities (WEFs) and associated infrastructure on separate sites located approximately 20 to 40km west of Aberdeen, Sarah Baartman District Municipality (Dr Beyers Naude Local Municipality) in the Eastern Cape Province (Figures 1 & 2). The two proposed renewable energy projects comprise (1) the FE Kudu Wind Energy Facility of up to 622.5MW generation capacity to be located on Portion 2 of Farm Oorlogspoort 85 (preferred project site of approximately ~9 170ha) and (2) the FE Tango Wind Energy Facility of up to 240MW generation capacity to be located Portion 1 of Farm Klipstavel 72 (preferred project site of approximately ~2 250ha).The entire extent of the two sites falls within the Beaufort West Renewable Energy Development Zones (i.e. REDZ Focus Area 11). The Applications for Authorisation for the two WEFs and associated grid connection infrastructure will therefore follow a Basic Assessment (BA) process.

Each of the two WEFs will comprise the following main infrastructural components:

- Wind turbines with a generation capacity of up to 7.5MW each;
- Concrete turbine foundations and turbine hardstands;
- An on-site substation hub incorporating:

- A132/33kV On-site substation;
- Switchyard with collector infrastructure;
- Battery Energy Storage System (BESS).

- A balance of plant area incorporating:

- Temporary laydown areas;
- A construction camp laydown and temporary concrete batching plant;
- Operation and Maintenance buildings,

- Cabling between the turbines, to be laid underground where practical.
- Access roads to the site and between project components with a width up to 10m and a servitude of 13.5m.

The proposed infrastructure is preliminarily and will be updated once an optimised layout with all sensitivities considered has been generated.

Provisional sensitivity mapping (SAHRIS palaeosensitivity map, DFFE Screening Tool) suggests that the majority of both sites is of Low Palaeosensitivity with small marginal areas of Very High Palaeosensitivity based on the presence here of potentially fossiliferous continental sediments of the Lower Beaufort Group (Karoo Supergroup) of Permian age (Figure 43). The present combined desktop and field-based palaeontological heritage report contributes palaeontological heritage data to the overarching Heritage Impact Assessments (HIAs) and EMPRs that are being compiled for the two FE WEFs near Aberdeen WEF by CTS Heritage, Cape Town (Contact details: Ms Jenna Lavin, CTS Heritage. 16 Edison Way, Century City, Cape Town. Tel: +27 (0)87 073 5739. Cell: +27 (0)83 619 0854. E-mail: info@ctsheritage.com). The independent EAP for this renewable energy project is Savannah Environmental (Pty) Ltd.

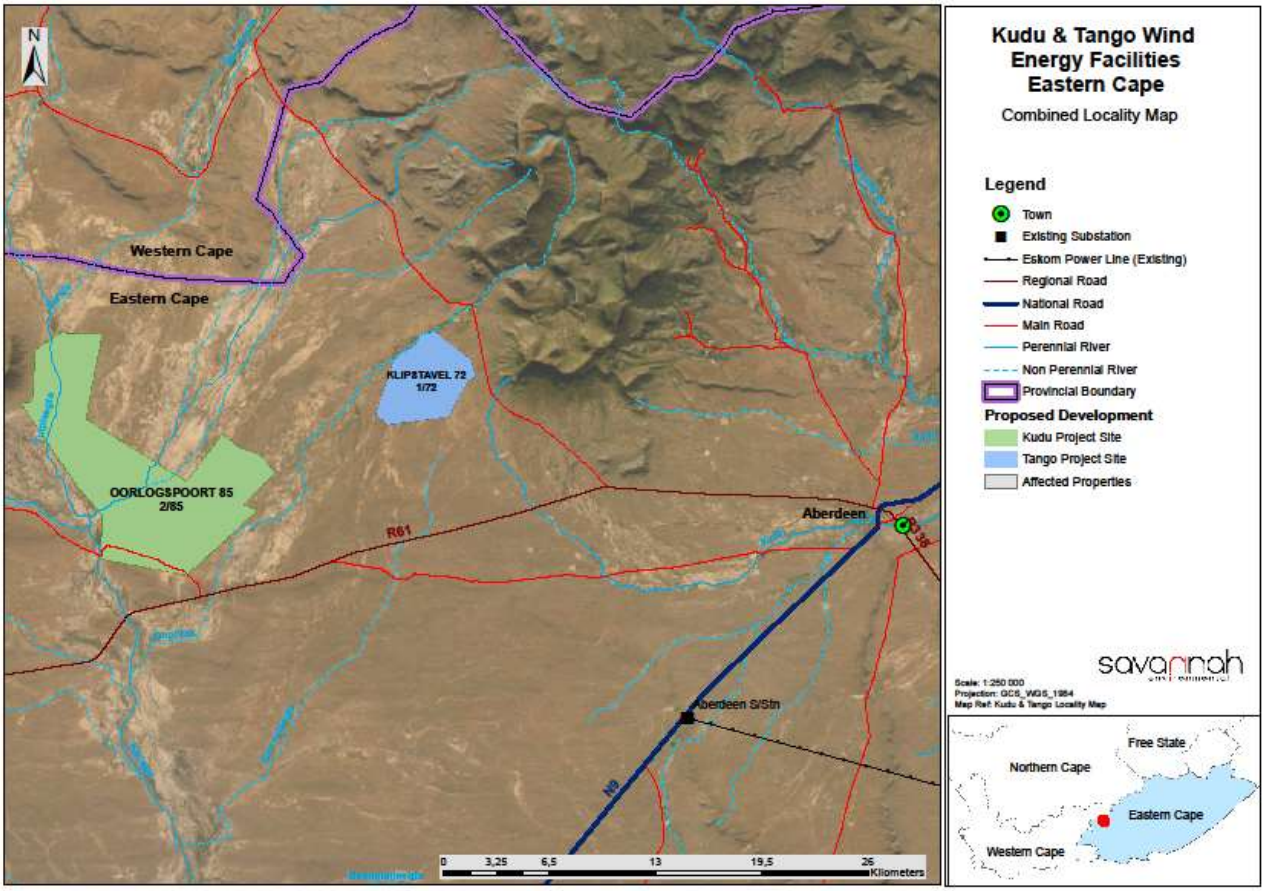

Figure 1: Map showing the location of the Kudu and Tango WEF project areas situated on the northern margins of the low-relief Aberdeen *Vlaktes* subregion of the Great Karoo, north of the R61 trunk road and approximately 20 to 40km west of Aberdeen, Sarah Baartman District Municipality (Dr Beyers Naude Local Municipality) in the Eastern Cape Province (Image prepared by Savannah Environmental).

Figure 2: Google Earth© satellite image of the northern margins of the Aberdeen *Vlaktes* and adjoining, dissected uplands of the Great Escarpment north of the R61 and to the west of Aberdeen, Eastern Cape. The Kudu WEF and Tango WEF project areas are indicated by dark and light blue polygons respectively. The majority of both areas is mantled by Late Caenozoic alluvial, eluvial and colluvial deposits related to the Kariegarivier drainage network draining the Great Escarpment towards the south. Bedrock exposures and largely limited to the eastern footslopes of the Oorlogskloofberge as well as baked sediments adjoining a major E-W trending dolerite dyke in the south.

2. INFORMATION SOURCES

This combined desktop and field-based palaeontological heritage study of the two FE WEF project areas near Aberdeen is based on the following information resources:

1. Short project outlines, kmz files, screening reports and maps provided by CTS Heritage, Cape Town;

2. A desktop review of:

(a) the relevant 1:50 000 scale topographic maps (3223AD Oorlogspoort, 3223BD Kamdeboo, 3223BC Kunna and 3223DA Kiwietskuil) as well as the 1:250 000 scale topographic map 3222 Beaufort West;
(b) Google Earth© satellite imagery;
(c) published geological and palaeontological literature, including the 1:250 000 geological map (3222 Beaufort West) and relevant sheet explanation (Johnson & Keyser 1979) as well as
(d) previous fossil heritage (PIA) assessments for mining and renewable energy projects in the Aberdeen *Vlaktes* subregion by Rubidge & Abdala (2008) and Almond (2014, 2022a, 2022b, 2023);
(e) Palaeontological data from the Karoo Fossil Database and additional unpublished information kindly provided by Dr Mike Day (Natural History Museum, London) and Professor Bruce Rubidge (Evolutionary Studies Institute, Wits University, Johannesburg);

3. The author's field experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008 and PIA reports listed in the References); and

4. A three-day field assessment of the two Aberdeen WEF project areas by the author during the period 9 to 11 June 2023. Given the generally extremely poor levels of bedrock exposure in the Aberdeen *Vlaktes*, fieldwork mainly focussed on examination of a representative selection of potentially fossiliferous bedrock exposures identified on the basis of Google Earth satellite imagery (many of which proved misleading in practice), especially those close to farm tracks, as well as relict alluvial gravels and calcretised older alluvial deposits. Given time constraints, it was not practicable to survey all parts of the huge project area, most of which is likely to be palaeontologically barren on the basis of satellite imagery.

The season in which the site visit took place has no critical bearing on the palaeontological study.

3. GEOLOGICAL CONTEXT

The Kudu WEF and Tango WEF project areas near Aberdeen feature low-relief, undulating to gently hilly, terrain of the Aberdeen *Vlaktes* of the Eastern Cape (Figures 2 & 4). Much of the area is clothed in sparse to dense karroid *bossieveld* with unvegetated pans and extensive open alluvial plains; woody vegetation dominated by thorn trees is mainly restricted to larger drainage lines. This portion of the Great Karoo region is located between outliers of the Great Escarpment represented by the Kamdebooberge in the east and the Oorlogspoortberge in the west. It is characterized by semi-arid, karroid vegetation, extensive sandy to gravelly alluvial plains (*c*. 840-870m amsl. in the Kudu WEF project area; 900-970 m amsl. in the Tango WEF project area), numerous shallow pans (*brak-kolle*), a few low E-W trending rocky ridges or *bulte* (*e.g.* near Rooidraai homestead) built of dolerite and baked metasediments and, for the most part, shallow, sandy to gravelly drainage lines. These last (*e.g.* Ouplaasrivier, Tulpleegte) mainly feed south-westwards into the wide, N-S trending Kariega River drainage system running to the southwest of the WEF project areas. The Aberdeen *Vlaktes* represent an ancient peneplanated land surface of possible Miocene age (Partridge & Maud 1987). As a result of protracted denudation, the gently dipping to regularly folded bedrocks have been planed down and extensively blanketed by colluvial, eluvial and alluvial sediments with extensive subsurface bedrock weathering and development of calcrete pedocretes. Due to the pervasive superficial sediment cover, levels of good, fresh bedrock exposure are generally rare to very rare in the Aberdeen *Vlaktes* region with occasional low exposures of channel sandstone beds in the lowlands and quartzitic baked sandstones and dolerite along the occasional ridges. Only a handful of – mainly small – mudrock exposures are encountered here, mainly comprising gullied areas on gentle to steep hillslopes as well as occasional “windows” through superficial sediments along active drainage lines (*e.g.* Kariegarivier near Rooidraai homestead). There are also occasional borrow pit exposures, such as those just east of Rooidraai homestead, which tend to be highly disturbed at surface.

The geology of the Great Karoo to the west of Aberdeen is depicted in 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria; Johnson & Keyser 1979) (Figure 3). The bedrocks underlying the study area are currently *mapped* within the lower portion of the **Teekloof Formation** (**Pt**) of the **Lower Beaufort Group** (Adelaide Subgroup, Karoo Supergroup) that is predominantly fluvial in origin (Johnson *et al.* 2006). The Lower Beaufort beds here were erroneously assigned by Almond (2014) in a previous PIA report to the mudrock-dominated **Hoedemaker Member** of Late Permian (Wuchiapingian) age (*c.* 260 Ma) (Smith & Keyser 1995, Rubidge 2005, Rubidge *et al.* 2013) while the thin, closely-spaced, prominent-weathering sandstones seen on the lower slopes of the Kamdebooberg escarpment to the northeast were assigned to the overlying **Oukloof Member** (*cf* stratigraphic table in Figure 33). However, subsequent biostratigraphic data based on more recent fossil tetrapod finds indicates that the somewhat older (Middle Permian) **Abrahamskraal Formation** occurs in the footslopes of the Oorlogspoortberge, on the western margins of the Kudu WEF project area, and further to the north towards Nelspoort (Dr Mike Day, Professor B. Rubidge, pers. comm., 2022) (Figure 32). This suggests that the Aberdeen *Vlakes* in the two Aberdeen WEF project areas are also underlain by the upper part of the Abrahamskraal Formation; the west-facing slopes of the Kamdebooberge to the east feature younger strata of the Poortjie, Hoedemaker and Oukloof Members of the Teekloof Formation while a probable Poortjie Member sandstone package can be seen on the east-facing slopes of the Oorlogspoortberge (Figure 5). The Beaufort Group bedrocks in the project area are extensively folded along E-W axes into low, open folds; this region accordingly lies within the northern margins of the Permo-Triassic Cape Fold Belt. Short, illustrated accounts of the poorly-exposed Abrahamskraal Formation and overlying Poortjie Member bedrocks in this northern

subregion of the Aberdeen *Vlaktes* have already been provided by Almond (2022b, 2023) and will not be repeated here.

Apart from scattered, low ridges and bands of highly fractured channel wackes and small areas of cleaved, grey-green siltstone with occasional rusty-brown ferruginous carbonate concretions in the *vlaktes*, as well as occasional borrow pit excavations showing folded and cleaved, weathered, calcrete-veined mudrocks (grey-green and minor purple-brown facies) and thin wackes, the best exposures of Beaufort Group bedrocks in the Kudu WEF project area are found on the lower eastern footslopes of the Oorlogspoortberge, close to the project area boundary (*cf* Figures 5 to 12). Here a thin, package of yellowish-brown weathering, thin-to medium-bedded, tabular, locally cross-bedded channel wackes with occasional large, lenticular concretions of ferruginous carbonate sharply overlies crumbly, weathered, grey-green overbank mudrocks containing occasional pedocrete concretions. The base of the package is erosional with local development of thin (*c*. 20 cm), lenticular mudflake intraclast breccias which are often associated with rusty-brown moulds of reworked woody plant axes (Section 5). This channel facies broadly resembles the Poortjie Member which may be more clearly represented higher up on the slopes of the Oorlogspoortberge (Figure 5); the fossiliferous beds on the western edge of the Kudu WEF project area might lie within the upper Abrahamskraal Formation or, alternatively, the base of the Poortjie Member (Teekloof Formation). Overlying mudrocks (*outside* the project area) show both grey-green and, much less commonly, purple-brown hues. Grey-green, fine-grained channel wackes with current ripple cross-laminated bedtops and local evidence of soft-sediment deformation (possibly dewatering) are exposed in a tributary of the Kariegarivier near Rooidraai homestead.

The Lower Beaufort Group country rocks are locally intruded by the **Karoo Dolerite Suite** of Early Jurassic age (Duncan & Marsh 2006). A laterally persistent, broadly W-E trending dyke of resistant-weathering dolerite runs along the southern margins of the Kudu WEF project area where it is expressed as a low rubbly ridge near Rooidraai homestead. Major, columnar-jointed dolerite sills are also visible further to the northeast in the upper slopes of the Kamdebooberg Escarpment (*e.g.* Sleeping Giant) and capping the Oorlogspoortberge in the west. Beaufort Group mudrocks and channel sandstones in the vicinity of the igneous intrusions have been baked to form dark hornfels and splintery, pale blue-green metaquartzite respectively; these tough lithologies form important raw materials for local Stone Age artefacts. Thin, prominent-weathering packages of tabular-bedded, occasionally small-scale wave-rippled, baked channel wackes of the upper Abrahamskraal Formation can be seen emerging from a mantle of doleritic colluvial gravels along the SSW-facing slopes of the ridge to the southeast of Rooidraai homestead (Figure 11). Small, patchy exposures of baked mudrocks in the vicinity are weathered and crumbly.

A wide spectrum of **Late Caenozoic superficial deposits** – mostly Quaternary or younger in age – overlies the Beaufort Group and Karoo dolerite bedrocks across the great majority of the Kudu WEF and Tango WEF project areas (Figures 13 to 31). Angular, blocky colluvial rubble of baked quartzite and dolerite mantles ridge slopes near Rooidraai. Low wacke (impure sandstone) ridges in low-lying terrain are often highly jointed and locally weather to form blocky eluvial gravels or well-rounded corestones. Extensive zones of relict, downwasted alluvial “High Level Gravels” margin the larger water courses (*e.g.* Ouplaasrivier) and form low stepped terraces or linear cobbly to bouldery zones in the adjoining *veld*; the clasts here include moderately to well-rounded pebbles, cobbles of brownish-orange patinated wacke, pale blue-grey, fine-grained quartzite, very dark hornfels, dolerite boulders, vein quartz, calcrete, pedocrete concretions, rare greenish, cherty tuffite and sparse to locally common petrified wood reworked from the Permian bedrocks. Some of this tough-weathering material which also dominates eluvial surface gravels in the region has been

transported downstream from the Escarpment Zone (*e.g.* doleritic boulder deposits). Thin alluvial and eluvial (downwasted), pebbly to cobbly and occasionally bouldery gravels of angular wacke / quartzite, hornfels, dolerite and vein quartz mantle large parts of the project area. Grey areas on satellite images often feature fine, flaky to crumbly mudrock / wacke clasts and / or greyish carbonate pedocrete concretions overlying sands rather than fine-grained bedrocks. Well-developed calcrete pedocretes are mainly developed along major drainage lines and probably also in close association with buried dolerite intrusions. Here older, orange-brown, polygonally veined, massive to finely nodular calcretes with sparse gravel clasts are overlain by younger, uncalcretised sandy alluvium. Most of the younger alluvium associated with currently active drainage lines consists of fine-grained sands and silts (locally reworked by wind) with lenses of coarser gravels (clasts of dolerite, wacke, quartzite, hornfels *etc*) at the base, dispersed calcrete glaebules and occasional sparse surface gravels, some of which are flaked and may well be manuports. Numerous, extensive pan areas (*brak-kolle*) are devoid of vegetation with floors of fine sand or silt which often underlain by a calcrete *dorbank*. The pan margins usually possess a sparse veneer of sheet-washed, pebbly to cobbly gravels of resistant rock-types (*e.g.* wacke, rare silicified wood, hornfels, quartzite *etc*) that are commonly anthropogenically flaked. Scattered bush clumps are associated with low mounds or *heuweltjies* of unusually thick silty to sandy soil. These areas are typically densely burrowed by mammals (aardvark, porcupines), often feature scattered modern bones, and may be associated with calcrete glaebules.

Representative exposures of the various bedrock and superficial sediment rock units present within the Kudu WEF and Tango WEF project areas are illustrated in Figures 4 to 23 and Figures 24 to 31 respectively.

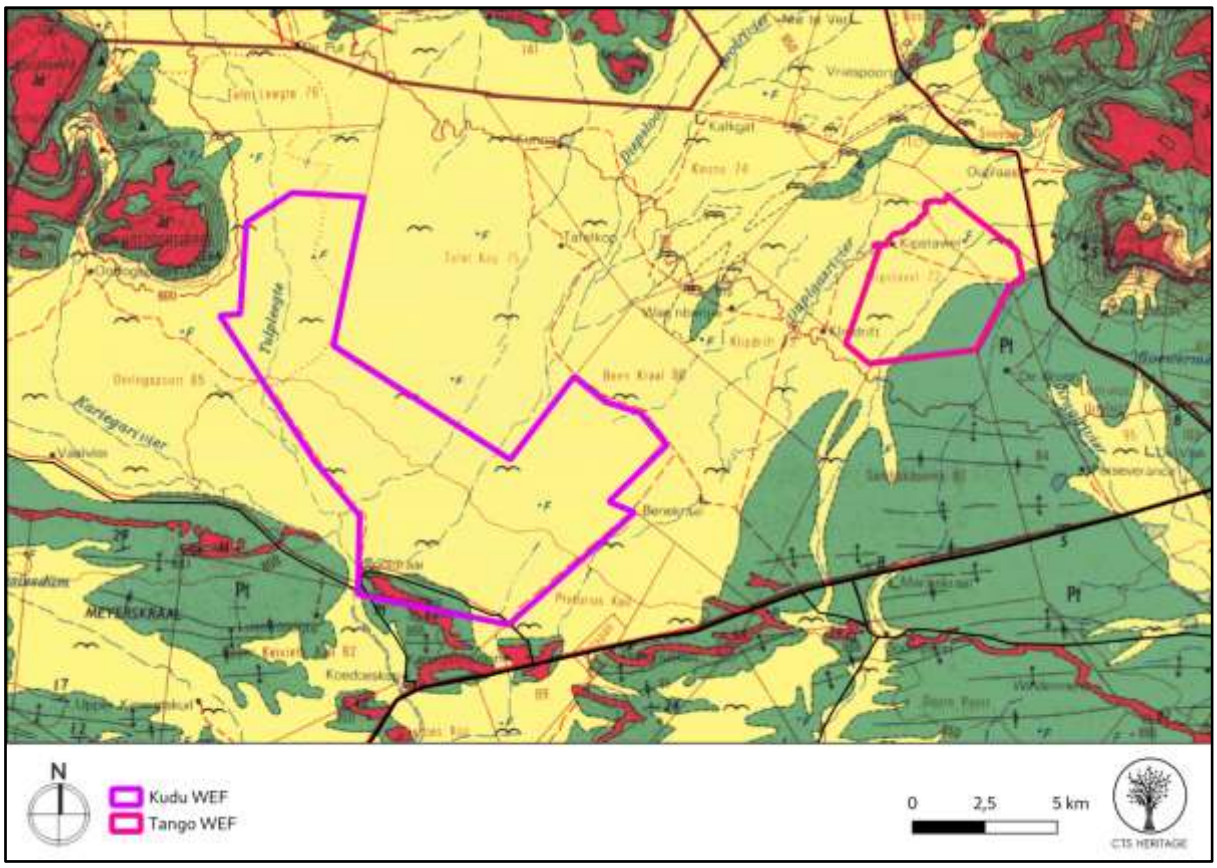

Figure 3: Extract from the 1: 250 000 geological map sheet 3222 Beaufort West (Council for Geoscience, Pretoria) showing the Kudu WEF (lilac polygon) and Tango WEF (pink polygon) project areas near Aberdeen. Exposures of potentially fossiliferous Lower Beaufort Group bedrocks (green) here are very limited. Recent palaeontological fieldwork suggests that these bedrocks belong to the upper Abrahamskraal Formation (*Tapinocephalus* Assemblage Zone) rather than the Teekloof Formation (Pt) as mapped here. Most of the project areas are mantled by Late Caenozoic sandy to gravelly alluvial deposits (yellow) that are generally of Low Palaeosensitivity. The bedrocks are locally intruded and baked by unfossiliferous Karoo dolerite (red) No historical fossil sites are mapped here within the WEF project areas (Image prepared by CTS Heritage).

Figure 4: General view eastwards across very low-relief terrain of the northern Aberdeen *Vlaktes* where the proposed Kudu WEF and Tango WEF will be situated, from the Oorlogspoortberge (rocky footslopes in foreground) towards the Kamdebooberg on the skyline.

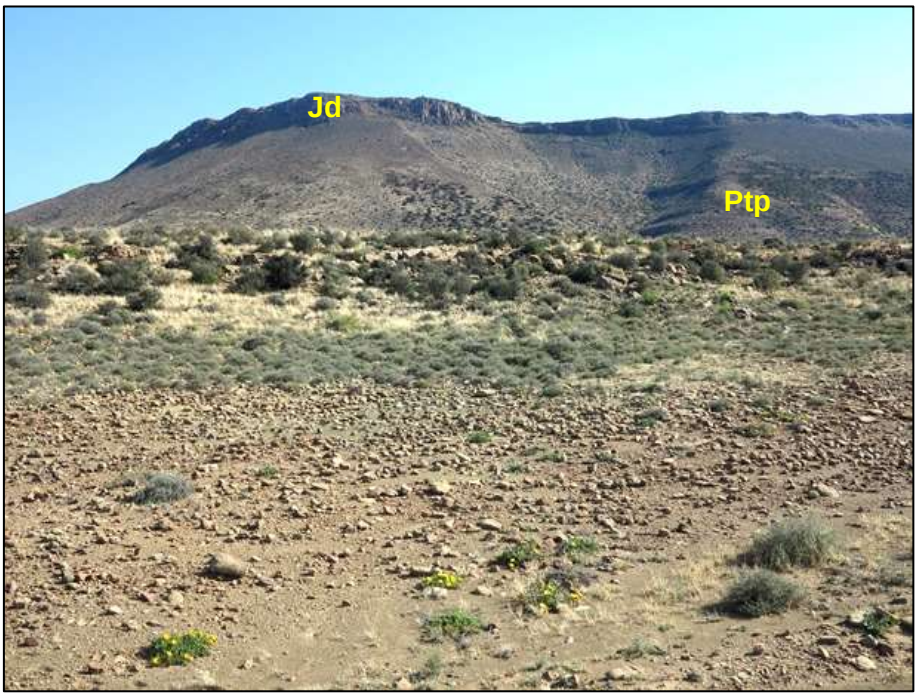

Figure 5: View of the Oorlogspoortberge from the east, situated on the western margins of (and largely *outside*) the Kudu WEF project area. Channel sandstones, assigned either to the upper Abrahamskraal Formation or the lower Poortjie Member (Teekloof Formation), building the low *kranz* in the middle ground – located just *inside* the Kudu WEF project area - contain locally abundant fossil debris of reworked woody plants. Ptp = Poortjie Member. Jd = sill of Karoo Dolerite Suite.

Figure 6: Close-up of the yellowish-brown weathering, tabular cross-bedded, poorly cemented channel sandstones building the low *kranz* seen in the previous figure (hammer = 30 cm). The sandstones display sedimentary and palaeontological facies typical of the Poortjie Member but might lie within the upper Abrahamskraal Formation.

Figure 7: Large, irregular to lenticular concretion of diagenetic ferruginous carbonate within the Poortjie-like channel sandstone unit illustrated above (hammer = 30 cm).

Figure 8: One of several lenses of mudflake-dominated breccio-conglomerate (behind hammer, 30 cm long) at the base of the channel sandstone package illustrated above. Such lenses are locally packed with ferruginized moulds of reworked woody plant debris and are the likely source of downwasted petrified wood in associated colluvial gravels (*cf* Figures 34 & 35).

Figure 9: Rare exposure of thinly interbedded wackes and grey-green mudrocks of the upper Abrahamskraal Formation within a borrow pit *c*. 750m east of the Rooidraai homestead. Ovedrlying coluvial gravels are calcretised. Minor purple-brown mudrocks are exposed elsewhere in the same borrow pit.

Figure 10: Ripple cross-laminated, greyish channel sandstones of the upper Abrahamskraal Formation exposed in a tributary stream of the Kariegarivier near Rooidraai homestead (hammer = 30 cm).

Figure 11: Low *kranz* of baked, tabular-bedded quartzite and hornfels of the upper Abrahamskraal Formation exposed among doleritic colluvial gravels on the south-facing slopes of the dolerite-intruded ridge, *c*. 900 m SE of Rooidraai homestead. Hammer = 30 cm.

Figure 12: Low exposures of cleaved, grey-green mudrocks of the Lower Beaufort Group in the north-eastern sector of the Kudu WEF project area (hammer = 30 cm).

Figure 13: Extensive bands of dark, patinated surface gravels in the north-eastern sector of the Kudu WEF project area are probably relict bars of older alluvial gravels. They are dominated by angular to subrounded dolerite, quartzite / wacke and hornfels clasts but sometimes contain very sparse reworked blocks of petrified wood.

Figure 14: Similar relict bars of dark alluvial gravels, seen here in the southern sector of the Kudu WEF project area. View towards the NE showing the Kamdebooberg in the background.

Figure 15: Relict "High Level" alluvial gravels in the NE sector of the Kudu WEF project area with extensive development of pale calcrete hardpan in the subsurface, perhaps associated with weathered dolerite clasts here.

Figure 16: Extensive, thin veneer of eluvial / reworked fluvial surface gravels typical of many portions of the Kudu WEF project area, seen here in the northeast. These gravels have yielded sparse reworked blocks of poorly- to well-preserved silicified fossil wood (*e.g.* Locs. 332, 333).

Figure 17: Downwasted eluvial gravels overlying semi-consolidated older sandy alluvium and mantled by unconsolidated younger alluvial sands, SE sector of Kudu WEF project area (hammer = 30 cm).

Figure 18: Flat-terrain with low karroid *bossieveld* vegetation and mantled by dark patches of downwasted / reworked, poorly-sorted older alluvial gravels (dolerite, wackes / quartzite, hornfels *etc*) are widely seen in the NE sector of the Kudu WEF project area.

Figure 19: Many darker grey patches seen on satellite images reflect surface gravels dominated by reworked platy grey-green mudrock gravels rather than *in situ* Lower Beaufort Group bedrocks, as seen here in the NE sector of the Kudu WEF project area. Such areas are generally unfossiliferous.

Figure 20: Older, semi-consolidated sandy alluvium containing abundant small calcrete glaebules exposed in shallowly dissected terrain some 900m east of the Rooidraai homestead.

Figure 21: Extensive open *vlaktes* dominated by unconsolidated, fine sandy to silty alluvium in the southern sector of the Kudu WEF project area. Bedrocks here my lie at depths of up to a few meters.

Figure 22: Much of the western sector of the Kudu WEF project area is dominated by fine sandy to silty alluvium and shallow, wooded channels of tributary streams of the Kariegarivier drainage system, such as the Tulpleegte.

Figure 23: Erosionally dissected areas within the sandy *vlaktes* the western sector of the Kudu WEF project area show that the fine alluvial deposits here are up to several meters thick. Bedrock exposure is non-existent, except along the most deeply incised drainage lines (*e.g.* Kariegarivier).

Figure 24: Well-developed, coarse, boulder alluvium exposed along the Ouplaasrivier along the northern edge of the Tango WEF project area. The boulders are mainly composed of reworked corestones of greyish Karoo dolerite derived from major sill intrusions in the Kamdebooberg escarpment to the east.

Figure 25: Several elongate, SE-NW trending darker patches on satellite images of the southern sector of the Tango WEF project area represent relict, coarse "High Level" alluvial gravels dominated by well-rounded boulders and cobbles of dark patinated Karoo dolerite.

Figure 26: Linear trains of well-rounded dolerite boulders in the southern sector of the Tango WEF project area probably represent re-exhumed ancient drainage lines, generating an inverted topography.

Figure 27: Sandy alluvial *vlaktes* with a sparse mantle of downwasted eluvial gravels on the western margins of the Tango WEF project area. Reworked petrified wood clasts are very rarely encountered here.

Figure 28: Similar, more erosionally dissected sandy and gravelly deposits in the eastern sector of the Tango WEF project area.

Figure 29: Donga erosion into thick sandy alluvium reveals widespread calcrete development in the subsurface, as seen here in eastern sector of the Tango WEF project area.

Figure 30: Thin, locally gravel-rich calcrete hardpan beneath semi-consolidated, orange-brown sandy alluvium exposed in a shallow stream bank, eastern sector of the Tango WEF project area (hammer = 30 cm).

Figure 31: Flat terrain within the south-eastern sector of the Tango WEF project area with occasional patches of thin, pebbly to cobbly alluvial to eluvial gravels dominated by Karoo quartzite / wacke, hornfels and dolerite with very rare blocks of petrified wood.

4. PALAEONTOLOGICAL HERITAGE CONTEXT

The Aberdeen *Vlaktes* are largely *Terra Incognita* in palaeontological terms due to the exceedingly poor levels of bedrock exposure in the region (*cf* fossil vertebrate site maps presented by Keyser & Smith (1977-1978), Nicolas (2007)). The 1: 250 000 geological map in Figure 3 shows no historical sites within the WEF Cluster project area. Rubidge and Abdala (1988) recorded a modest number of small dicynodonts, large therocephalian postcranial remains and fossil wood from a series of farms extending across the Karoo *vlaktes* to the south-west of Oorlogspoortberge, due southwest of the present study area. The fossils were provisionally assigned to the formerly recognised *Pristerognathus* AZ (but might belong, at least in part, to the upper *Tapinocephalus* AZ. A PIA report by Almond (2014) for a 200MW WEF project area, situated just east of and directly south of the Kudu WEF and Tango WEF project areas respectively, recorded locally abundant petrified wood within surface gravels but no fossil vertebrate remains. No PIA reports were submitted for the proposed Biotherm Aberdeen PV/CPV Solar Energy Facility on Portion 1 of The Farm Wildebeest Poortje near Aberdeen, Camdeboo Municipality, Eastern Cape or the proposed Camdeboo Wind Energy Facility near Aberdeen Eastern Cape (CTS, pers. com., 2022). Recent PIA studies by Almond (2002a, 2022b, 2023) for solar project areas near Nelspoort as well as the Aberdeen Cluster WEFs and Kariega WEF in the vicinity of the Kudu and Tango WEFs yielded only very rare fossil tetrapod remains; these are of scientific interest because they probably include dinocephalians from the upper Abrahamskraal Formation. A local abundance of fossilized woody plant material (much of it poorly preserved as ferruginised moulds) was recorded here within the inferred lower part of the Poortjie Member as well as widespread scatter of silicified wood blocks within the Late Caenozoic superficial deposits. The petrified wood blocks here are probably derived both from channel sandstone bodies within the upper Abrahamskraal Formation as well as the overlying Poortjie Member.

As discussed above, recent fossil collection by Wits University palaeontologists (Bruce Rubidge, Mike Day *et al*.) from better bedrock exposures within the Great Escarpment Zone (e.g. Oorlogspoortberge, foothills of the Kamdebooberg) suggests that the majority (and perhaps all) of the Lower Beaufort Group bedrocks in the present project area belong to the upper part of the Abrahamskraal Formation and *not* the Teekloof Formation as mapped (*cf* Figure 3). Fossil assemblages of the Middle Permian ***Tapinocephalus* Assemblage Zone** may therefore be expected here, but supporting material is exceedingly scarce. This revised biostratigraphy is reflected, albeit provisionally, in the most recent biozonation mapping of the Main Karoo Basin by Day & Rubidge (2020a) which shows an unconfirmed tongue of “Tap Zone” outcrop extending into the Aberdeen Vlaktes region from the south (Figure 32) (contrast the earlier account by Almond 2014, now outdated).

Continental (terrestrial / lacustrine / fluvial) fossil biotas within the upper part of the Abrahamskraal Formation (Moordenaars and Karelskraal Members) as well as within the lowermost portion of the Poortjie Member of the Teekloof Formation are now assigned to the ***Diictodon* – *Styracocephalus* Subzone** of the revised ***Tapinocephalus* Assemblage Zone** (AZ) that is of Late Capitanian age (*c*. 262-260 Ma) (Day & Rubidge 2020a) (Figure 33). The highly impoverished, post-extinction vertebrate fauna represented in the uppermost part of the *Diictodon* – *Styracocephalus* Subzone (lowermost Poortjie Member) includes – or is inferred to include – only a few representatives of several tetrapod subgroups. These include amphibians, parareptiles (pareiasaurs, *Eunotosaurus*), dinocephalians (*e.g. Criocephalosaurus,* perhaps also *Styracocephalus*), dicynodonts (*e.g. Diictodon*), therocephalians (*e.g. Pristerognathus*) and

gorgonopsians (Retallack *et al* 2006, Smith *et al.* 2012, Day *et al.* 2015a, 2015b, Day & Rubidge 2020a).

The fossil record of the Abrahamskraal – Teekloof contact zone is of special scientific interest because of its record of environmental and palaeobiological events related to the major **Middle Permian Mass Extinction Event** of 262-260 million years ago (= Capitanian or Guadalupian Mass Extinction Event) (Day *et al.* 2015b). Since vertebrate fossils are generally rare within this interval, any new records of well-preserved, identifiable material here are of considerable scientific value (*cf* ongoing research project on this extinction event conducted by Professor Bruce Rubidge of Wits University and colleagues elsewhere).

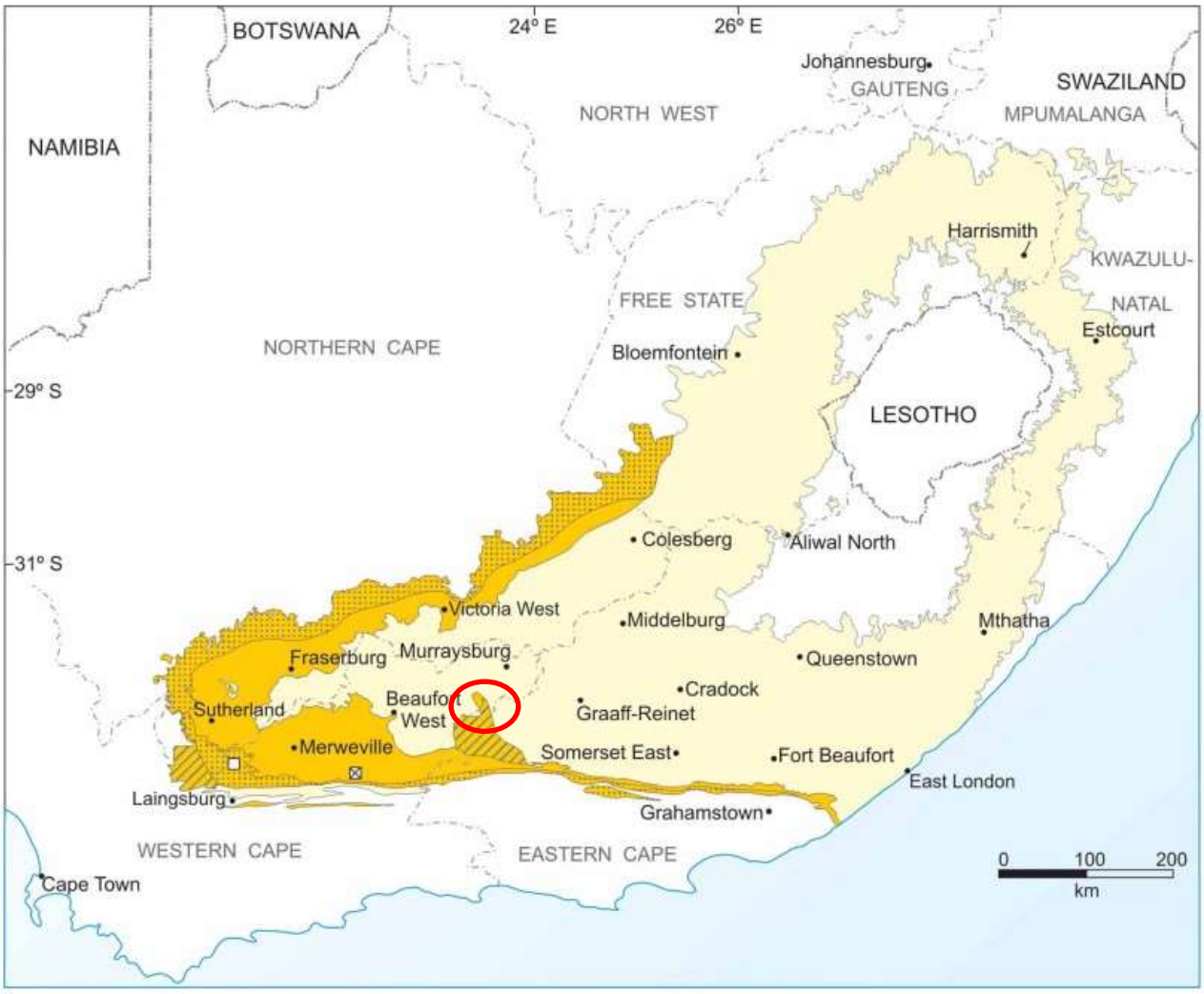

Figure 2. *Distribution of the* Tapinocephalus *Assemblage Zone (dark yellow) in the Beaufort Group (yellow), showing the distribution of the* Eosimops – Glanosuchus *Subzone (dotted),* Diictodon – Styracocephalus *Subzone (not dotted), and uncertain presence (diagonal hatched). Positions of Type localities for the* Eosimops – Glanosuchus *Subzone (empty square) and* Diictodon – Styracocephalus *Subzone (crossed square) are indicated.*

Figure 32: The most recent fossil biozonation mapping of the *Tapinocephalus* Assemblage Zone in the Main Karoo Basin by Day and Rubidge (2020a) indicates a region of the Onder Karoo between Beaufort West and Aberdeen where the presence of this AZ is uncertain (red ellipse) but strongly suggested by recent fossil finds. Any identifiable new tetrapod (and possibly also woody) fossil material from the Aberdeen *Vlaktes* may help clarify these biostratigraphic ambiguities.

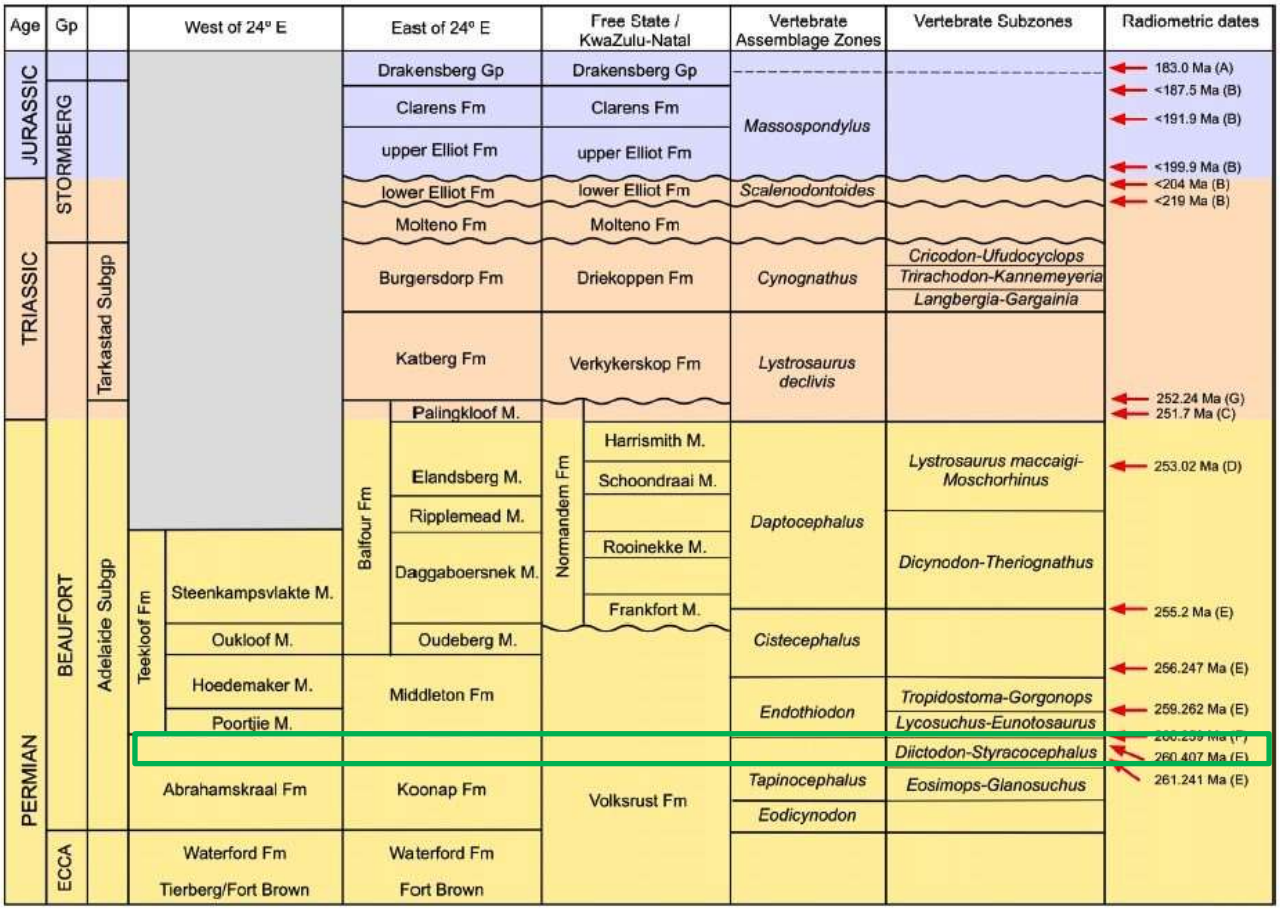

Figure 33: Stratigraphic subdivision of the Karoo Supergroup with the rock units and fossil biozones most relevant to the present Kudu WEF and Tango WEF study areas outlined in green (Modified from Smith *et al.* 2020). Recent Karoo fossil biozonation mapping suggests that Lower Beaufort Group bedrocks underlying the WEF project areas contain fossil assemblages within the Abrahamskraal Formation assigned to – probably the upper part of - the *Tapinocephalus* Assemblage Zone (green rectangle). Previous geological mapping suggested a high stratigraphic placement within the Teekloof Formation associated with *Endothiodon* Assemblage Zone fossil assemblages (previously assigned to the *Pristerognathus* AZ). The Poortjie, Hoedemaker and Oukloof Members of the Teekloof Formation are represented in the slopes of the Kamdebooberge Escarpment to the northeast of the WEF Cluster project area. Channel sandstones within the basal part of the Poortjie Member might extend into the western margins of the Kudu WEF project area on the lower footslopes of the Oorlogspoortberge.

4. RESULTS FROM PALAEONTOLOGICAL SITE VISIT

Most of the palaeontological fieldwork for the present site visit focussed on sporadic, darker, greyish areas seen on satellite images of the WEF project areas (Figure 2) which, in some cases at least, are associated with local exposures of Lower Beaufort Group mudrocks (many only feature loose, shaley surface gravels or sandstone, however). A representative sample of areas with dark-hued relict alluvial gravels were also intensively searched for reworked petrified wood blocks. Less attention was paid to rare sandstone exposures, although these may also contain valuable reworked fossil vertebrate and woody plant material in the Abrahamskraal Formation and overlying Poortjie Member channel packages. No fossils were observed within diagenetic ferruginous carbonate concretions (elsewhere associated with fossil plants in the Poortjie Member, for example) or within occasional greyish pedogenic palaeocalcrete concretions, either *in situ* or reworked into surface gravels.

Fossil heritage resources recorded during the recent 3-day site visit to the WEF project areas are briefly documented in Appendix 1 with representative illustrations provided in Figures 34 to 42 below. No fossil vertebrate specimens were recorded during the site visit; previous PIA studies in the northern Aberdeen *Vlaktes* indicate that these are very rare in low relief areas (*cf* Almond 2022a, 2022b, 2023). The only trace fossils encountered were concentrations of probable calcretised subvertical plant root casts within thick sandy alluvial deposits of Late Caenozoic age (Figure 42); such occurrences are widespread within the Great Karoo region and of limited palaeontological interest.

A sparse background scatter of reworked blocks of petrified (silicified) wood in many different hues (pale grey to black, pearly, orange-brown, pale brown *etc*, in part reflecting different iron and manganese content) occurs widely within alluvial and eluvial surface gravels across the Kudu WEF Cluster project area (Figures 35 to 40) (*N.B.* The sites noted in Appendix 1 and on satellite map Figure A1 probably represent only a *small fraction* of all fossil wood occurrences within the WEF project areas). However, only one example – albeit with well-preserved woody fabric – was recorded within the Tango WEF project area (Figure 41). Fossil wood may be concentrated in remanié / eluvial gravels at the contact between superficial sands and bedrock as well as in stream gravels. A large proportion of the wood blocks show only partially or poorly-preserved xylem fabrics which may reflect different levels of microbial decomposition before or at the time of diagenetic silicification. However, some of the blocks from the same areas do show well-developed seasonal growth rings and excellent preservation of xylem tissue. This better-preserved material is potentially identifiable to genus or species level on the basis of the woody microstructure, and may help refine the local biostratigraphy; unfortunately many Permian wood taxa have long stratigraphic ranges (*cf* Bamford 1999, 2000). Day and Rubidge (2020a) list the genera *Australoxylon* and *Prototaxoxylon* from the Middle Permian Tap Zone beds (Fossil wood taxa for the overlying *Endothiodon* AZ are not listed by Day & Smith (2020)). Bamford (1999) notes that *Australoxylon* also occurs within the lowermost Teekloof Formation / Poortjie Member at Stellenboschvlei, north of the Oorlogskloofberge, but recent dinocephalian finds here suggest this area might also lie within the Abrahamskraal Formation (or perhaps the lower Poortjie Member).

Many of the fossil wood blocks recorded within the WEF project areas near Aberdeen, including those within alluvial gravels, are subangular to angular and do not appear to have suffered extensive transport, while some small blocks are well-rounded. Such material is extremely tough-weathering and can potentially be transported far from source by vigorous streams. Denser scatters of fossil wood blocks occur among colluvial gravel aprons in the vicinity of breccio-

conglomerate lenses at the base of channel sandstone packages on the western edge of the Kudu WEF project area; locally abundant, ferruginised moulds of woody plant axes are seen within the channel breccias themselves (Figures 8 & 34). As previously discussed, these fossiliferous, yellowish-weathering, cross-bedded channel sandstone bodies might lie within the base of the Poortjie Member or perhaps rather within the uppermost part of the Abrahamskraal Formation. Almond (2023) has described the sudden increase in transported fossil wood material found in the inferred basal Poortjie Member within the Kariega WEF project area near Aberdeen.

Good sections through Late Caenozoic superficial deposits suitable for palaeontological prospecting are rare in the Aberdeen *Vlaktes* region. No fossil material was observed within deposits such as thicker alluvial sands and calcretes, apart from the calcretised rhizoliths mentioned above (similar results were found by Almond 2014, 2022b, 2023). Reworked blocks of petrified wood are common, and locally abundant within alluvial / eluvial surface gravels, as discussed above.

Figure 34: Rusty-brown moulds of reworked woody plant axes weathered out of mudclast breccias at the base of a thin package of yellowish-brown channel wackes (uppermost Abrahamskraal Fm or basal Poortjie Member, Teekloof Fm), Portion 2 of Farm Oorlogspoort 85 (Loc. 353). Scale = *c*. 15cm.

Figure 35: Locally abundant blocks of poorly-preserved silicified wood weathered-out from the channel sandstone package just above, Portion 2 of Farm Oorlogspoort 85 (Loc. 355). Scale = *c*. 15 cm.

Figure 36: Scatter of well-preserved petrified wood blocks (with seasonal growth lines) as well as poorly-preserved, amorphous blocks among surface gravels, Portion 2 of Farm Oorlogspoort 85 (Loc. 350). Largest block is *c*. 13 cm across.

Figure 37: Reworked blocks of poorly-preserved silicified wood showing amorphous structure (possibly partially decomposed before silicification) recorded within a dense surface scatter of cobbly eluvial to alluvial gravels, Portion 2 of Farm Oorlogspoort 85 (Loc. 333). Scale = *c*. 15 cm.

Figure 38: Isolated block of colour-banded petrified wood recorded within a band of relict "High Level" alluvial gravels, Portion 2 of Farm Oorlogspoort 85 (Loc. 331). Scale in cm and half cm.

Figure 39: Blocks of cherty, colour-banded petrified wood recorded within eluvial surface gravels, Portion 2 of Farm Oorlogspoort 85 (Loc. 306). Block is *c*. 9 cm across.

Figure 40: Small block of well-preserved, cherty, grey-green petrified wood recorded from sheet-washed eluvial surface gravels within a pan-like *brak-koll* in sandy *vlaktes*, Portion 2 of Farm Oorlogspoort 85 (Loc. 335). Block is *c*. 8.5 cm across.

Figure 41: Rare, reworked block of pale, silicified wood showing well-preserved seasonal growth lines recorded from extensive area of greyish surface gravels (wacke, dolerite *etc*) on Portion 1 of Farm Klipstavel 72 (Loc. 370). Block is *c*. 11 cm across. This is the only petrified wood specimen recorded within the Tango WEF project area.

Figure 42: Thick sandy alluvium exposed in the banks of a deeply-incised, narrow drainage line showing numerous vertical pale structures – possibly calcretized rhizoliths (root traces), Portion 1 of Farm Klipstavel 72 (Loc. 383).

5. SITE SENSITIVITY VERIFICATION

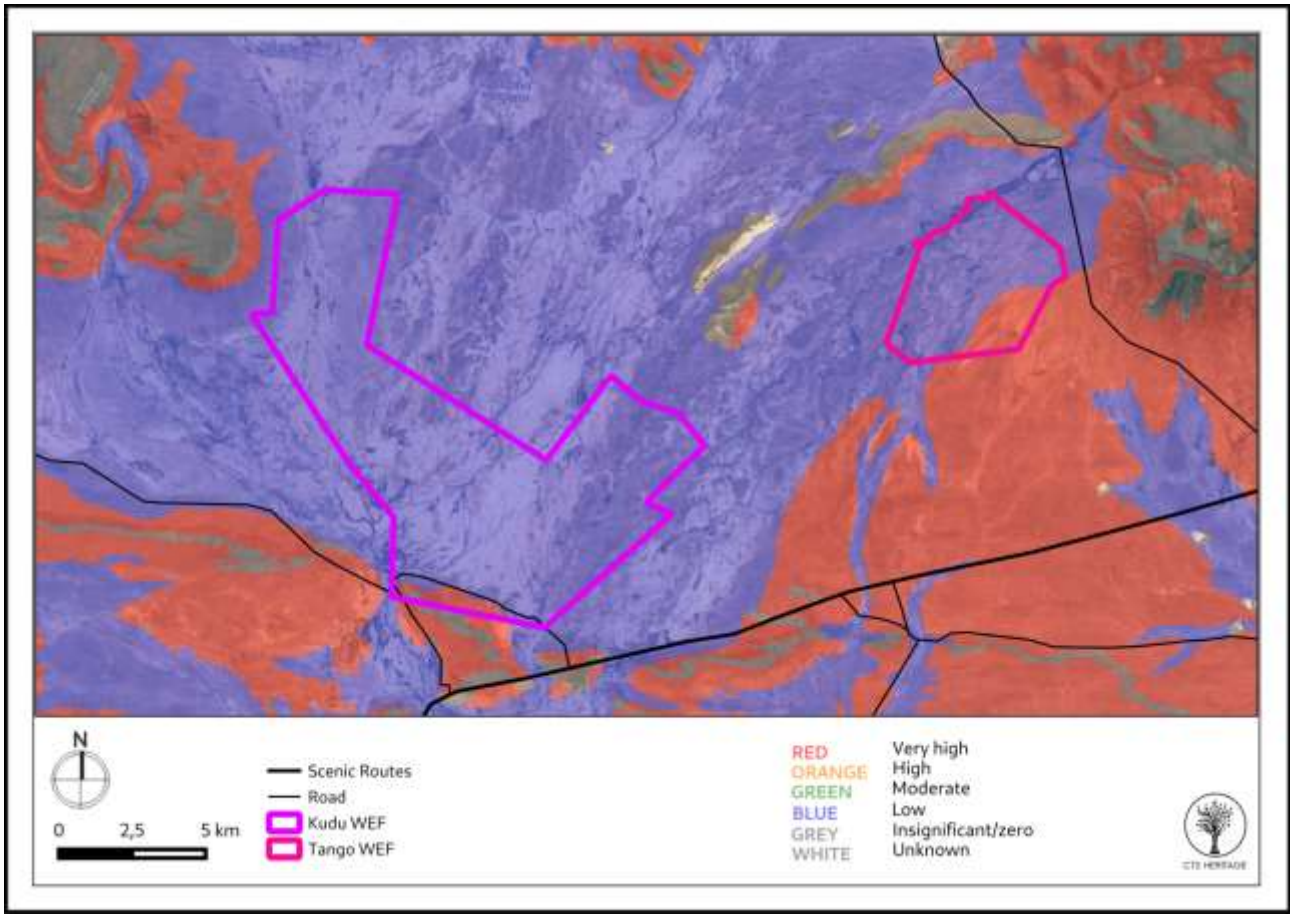

Figure 43: Provisional palaeosensitivity mapping for the Kudu WEF and Tango WEF project areas (lilac and pink polygons, respectively) (Image based on the DFFE Screening Tool and provided by CTS 2023). The Very High Palaeosensitivity shown for outcrop areas of the Lower Beaufort Group is *contested* in the present report since bedrock exposure levels here are generally very low and very few vertebrate fossils of scientific and conservation value have been recorded regionally. A small outcrop area of fossiliferous Lower Beaufort Group bedrocks on the footslopes of the Oorlogspoortberge (northwestern edge of the Kudu WEF project area) is not addressed on the map. Areas featuring substantial alluvial deposits are rated as of Low Palaeosensitivity and this particular assessment is upheld by this report.

Preliminary palaeosensitivity mapping of the Kudu WEF and Tango WEF project areas near Aberdeen based on the DFFE Screening Tool is shown above in map Figure 43. Limited outcrop areas of Lower Beaufort Group bedrocks shown on the 1: 250 000 geology map (Figure 3) are assigned a Very High palaeosensitivity, extensive mapped alluvial areas a Low palaeosensitivity and dolerite intrusions an Insignificant / Zero palaeosensitivity.

Historically almost no vertebrate fossil sites have been recorded within the wider Aberdeen *Vlaktes* subregion (Section 4). Based on the recent 3-day palaeontological site visit, the great majority of the Kudu WEF and Tango WEF project areas is mantled by thin to thick (several m) superficial deposits (alluvium, colluvium / eluvium, calcrete, pan sediments, soils) of low palaeosensitivity (Section 3). No tetrapod fossils were recorded from Lower Beaufort Group bedrocks here while

previous PIA studies indicate that vertebrate remains are very rare in the low-relief terrain of the Aberdeen *Vlaktes* (*e.g.* Almond 2022b, 2023). Blocks of reworked fossil wood occur widely as a background scatter across the more gravelly portions of the Kudu WEF project area and may be locally quite common; however, a minority of the material is well-preserved and of scientific interest and most occurrences are rated as of low heritage significance. In contrast, only a single petrified wood block has been recorded within the Tango WEF project area. Apart from calcretised plant roots of limited scientific interest, and the reworked fossil wood material mentioned earlier, no fossils have been recorded within the Late Caenozoic superficial deposits (alluvium, colluvium, surface gravels, soils, calcretes *etc*). that cover the majority of both WEF project areas

It is concluded that the project areas of both the Kudu WEF and Tango WEF are in practice of Low Palaeosensitivity overall, so the preliminary DFFE site sensitivity mapping shown in Figure 43 is *contested* here.

6. CONCLUSIONS & RECOMMENDATIONS

The Kudu WEF and Tango WEF project areas on the northern margins of the Aberdeen *Vlaktes* are underlain at depth by potentially fossiliferous continental (fluvial / lacustrine) bedrocks of the Lower Beaufort Group (Adelaide Subgroup). These bedrocks probably belong largely or entirely to the Middle Permian Abrahamskraal Formation rather than the Late Permian Teekloof Formation as currently mapped. However, basal channel sandstones of the Poortjie Member (Teekloof Formation) might extend into the NW edges of the Kudu WEF project area on the lower footslopes of the Oorlogspoortberge. There are no historical records of fossil vertebrates from the two project areas; this is probably largely due to the extremely poor levels of bedrock exposure found here. Fragmentary remains of large dinocephalians have recently been recorded from the Aberdeen *Vlaktes* just to the south as well as from the slopes of the Oorlogskloofberge to the west. During the recent 3-day palaeontological field visit no occurrences of fossil vertebrates were recorded.

A background scatter of petrified (silicified) wood blocks reworked from the Lower Beaufort Group bedrocks occurs within surface gravels of eluvial and alluvial origin in several sectors of the Kudu WEF project area. Locally abundant, ferruginised moulds and poorly-preserved petrified wood occurs in association with channel sandstone basal conglomerates on the NW margins of the Kudu WEF project area (Oorlogspoortberge eastern footslopes). Most of the fossil wood material is poorly preserved and of very limited scientific value. Only one, fairly well-preserved block of Palaeozoic petrified wood, was recorded within the Tango project area. Mitigation of the recorded fossil wood sites is not recommended here, given the abundance and widespread occurrence of better-preserved material regionally in the northern Aberdeen *vlaktes* and the fact that the material is not *in situ*.

Most of the low-relief terrain within the WEF project areas is covered by a thin to thick blanket of Late Caenozoic superficial deposits, including alluvial gravels and sands, eluvial and colluvial surface gravels, calcrete hard pans, pan sediments and gravelly to sandy soils. Apart from reworked fossil wood blocks and Late Caenozoic calcretised plant root casts of widespread occurrence and limited palaeontological interest, no fossils of Caenozoic age have been recorded within these younger sediments.

Given the rarity of significant vertebrate and other fossil finds and the very low surface exposure levels of Lower Beaufort Group bedrocks within the Kudu WEF and Tango WEF project areas due

to the widespread alluvial cover, the overall palaeosensitivity of both project areas is assessed as LOW. The provisional Medium to Very High Palaeosensitivity mapped here by the DFFE Screening Tool is accordingly *contested*. The potential for occasional fossil vertebrate sites of Very High palaeosensitivity cannot be entirely excluded, however. The distribution of such sites is largely unpredictable and they are best mitigated through a Chance Fossil Finds protocol.

The impact significance of the proposed Kudu WEF and Tango WEF developments on local palaeontological heritage resources is assessed as LOW. The projects are not fatally flawed and there are no objections on palaeontological heritage grounds to their authorization. This assessment applies equally to all infrastructure components and layout options currently under consideration. Pending the discovery of new fossil sites in the Pre-Construction or Construction Phase, micro-siting of infrastructure (*e.g.* wind turbines, access roads) in relation to known fossil sites is not considered necessary.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Kudu WEF and Tango WEF developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, burrows, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by the ECO/ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds such as vertebrate bones, teeth and well-preserved petrified logs should be safeguarded and reported at the earliest opportunity to the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a fossil collection permit from ECPHRA. Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013). These recommendations must be included in the EMPr for the proposed renewable energy developments.

7. ACKNOWLEDGEMENTS

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9. SHORT CV OF AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and the University of Tübingen in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa and Madagascar. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out numerous palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest Province, Mpumalanga, Gauteng, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, 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.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**

APPENDIX 1: KUDU WEF & TANGO WEF NEAR ABERDEEN FOSSIL SITE DATA – JUNE 2023

All GPS readings were taken in the field using a hand-held Garmin GPSmap 65s instrument. The datum used is WGS 84.

Please note that:

- Locality data for South African fossil sites in *not* for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but those sites recorded during the field survey (*N.B.* many background scatter occurrences of petrified wood are *not* included here since the material is widespread and occasionally common with surface gravels). The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- The stratigraphic data for each site has yet to be confirmed (probably Abrahamskraal Formation – member uncertain – but some fossil wood may be worked from higher stratigraphic levels within the Great Escarpment zone).

The recorded fossil sites are mapped with reference to the Kudu WEF and Tango WEF project areas in satellite image Figure A1 below.

LOC	GPS DATA	COMMENTS
306	-32.498458° 23.606089°	Portion 2 of Farm Oorlogspoort 85. Sparse blocks of colour-banded petrified wood within eluvial surface gravels. Proposed Field Rating IIIC. No mitigation recommended.
331	-32.446002° 23.619753°	Portion 2 of Farm Oorlogspoort 85. Isolated block of colour-banded petrified wood within band of relict "High Level" alluvial gravels. Proposed Field Rating IIIC. No mitigation recommended.
332	-32.450711° 23.616316°	Portion 2 of Farm Oorlogspoort 85. Dense surface scatter of cobbly eluvial to alluvial gravels with occasional reworked blocks of poorly-preserved silicified wood showing amorphous structure (possibly partially decomposed before silicification). Proposed Field Rating IIIC. No mitigation recommended.
333	-32.451702° 23.616341°	Portion 2 of Farm Oorlogspoort 85. Dense surface scatter of cobbly eluvial to alluvial gravels with occasional reworked blocks of poorly-preserved silicified wood showing amorphous structure (possibly partially decomposed before silicification). Proposed Field Rating IIIC. No mitigation recommended.
335	-32.485734° 23.591707°	Portion 2 of Farm Oorlogspoort 85. Sheet-washed eluvial surface gravels within pan-like *brak-koll* in sandy *vlaktes* with occasional small blocks of well-preserved, cherty, grey-green petrified wood. Proposed Field Rating IIIC. No mitigation recommended.
343	-32.455503° 23.563173°	Portion 2 of Farm Oorlogspoort 85. Patch of dark greyish, pebbly surface gravels with occasional small blocks of poorly-preserved, reworked petrified wood. Proposed Field Rating IIIC. No mitigation recommended.
350	32.373267° 23.529151°	Portion 2 of Farm Oorlogspoort 85. Sparse scatter of well-preserved petrified wood blocks (with seasonal growth lines) as well as poorly-preserved, amorphous blocks among surface gravels. Proposed Field Rating IIIC. No mitigation recommended.
351	-32.390249° 23.507883°	Portion 2 of Farm Oorlogspoort 85. Surface colluvial to eluvial gravels mantling eastern footslopes of Oorlogspoortberge with sparse blocks of poorly-preserved silicified wood downwasted from channel sandstone package upslope to the west. Proposed Field Rating IIIC. No mitigation recommended.

353	-32.390722° 23.503850°	Portion 2 of Farm Oorlogspoort 85. Mudclast breccias at base of thin package of yellowish-brown channel wackes (uppermost Abrahamskraal Fm or basal Poortjie Member, Teekloof Fm) containing abundant rusty-brown moulds of reworked woody plant axes. Proposed Field Rating IIIC. No mitigation recommended.
354	-32.392891° 23.504234°	Portion 2 of Farm Oorlogspoort 85. Surface colluvial to eluvial gravels mantling eastern footslopes of Oorlogspoortberge with sparse blocks of poorly-preserved silicified wood downwasted from channel sandstone package upslope to the west. Proposed Field Rating IIIC. No mitigation recommended.
355	-32.392969° 23.504141°	Portion 2 of Farm Oorlogspoort 85. Locally abundant blocks of poorly-preserved silicified wood weathered-out from channel sandstone package just above. Proposed Field Rating IIIC. No mitigation recommended.
370	-32.408641° 23.753921°	Portion 1 of Farm Klipstavel 72. Extensive area of greyish surface gravels (wacke, dolerite *etc*) with rare reworked blocks of pale silicified wood showing well-preserved seasonal growth lines. Proposed Field Rating IIIC. No mitigation recommended.
383	-32.394122° 23.765050°	Portion 1 of Farm Klipstavel 72. Thick sandy alluvium exposed in banks of deeply-incised, narrow drainage line showing numerous vertical pale structures – possibly calcretized rhizoliths (root traces). Proposed Field Rating IIIC. No mitigation recommended.

Figure A1: Google Earth© satellite image showing the location of the recorded fossil sites – yellow numbered circles – within the Kudu WEF and Tango WEF project areas (dark blue and pale blue polygons respectively) which are tabulated above (*N.B.* A widespread background scatter of additional, unrecorded fossil wood blocks can be expected here within surface deposits). None of the recorded fossil sites is of high scientific or conservation value and therefore no mitigation in their regard is proposed here. Numbered yellow squares outside the present study areas refer to fossil sites in the northern Aberdeen *Vlaktes* that have been recently recorded by Almond (2022b, 2023).

APPENDIX 2: CHANCE FOSSIL FINDS PROTOCOL

<table>
<tr><th colspan="3">KUDU WEF & TANGO WEF NEAR ABERDEEN</th></tr>
<tr><td>Province & region:</td><td colspan="2">Eastern Cape Cape; Sarah Baartman District , Dr Beyers Naude Local Municipality</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group) possibly extending upwards into Poortjie Member of Teekloof Formation, Late Caenozoic alluvium, colluvium, calcrete pedocretes, pan sediments, surface gravels & soils</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, trace fossils (e.g. vertebrate and invertebrate burrows), trackways, petrified wood, plant-rich beds in the Lower Beaufort Group bedrocks.
Fossil mammal bones, teeth, horn cores, freshwater molluscs, calcretised trace fossils (e.g. termitaria, rhizoliths), plant material in Late Caenozoic alluvium, calcretes.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>