PALAEONTOLOGICAL HERITAGE: COMBINED DESKTOP & FIELD ASSESSMENT

Proposed Bayview Wind Farm near Uitenhage, Uitenhage District, Eastern Cape

John E. Almond PhD (Cantab.)
***Natura Viva* cc, PO Box 12410 Mill Street,**
Cape Town 8010, RSA
naturaviva@universe.co.za

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EXECUTIVE SUMMARY

The proposed Bayview Wind Farm on farms Ebb & Vloed, Remaining Extent of 8/230, Olifantskop RE/201 and Steins Valley 4/202, will be situated to the west of the Sundays River Valley *c.* 25 km northeast of Uitenhage in the Uitenhage District, Eastern Cape. It will have a maximum of 45 wind turbines and a generating capacity of up to 135 MW,

The wind farm project area, situated on the Grassridge Plateau inland from Algoa Bay, is largely underlain by Neogene (Late Tertiary) shallow marine deposits of the Alexandria Formation (Algoa Group) as well as Early Cretaceous sandstones and mudrocks of the Sundays River Formation (Uitenhage Group). Younger superficial sediments in the area include Plio-Pleistocene alluvial terrace deposits of the Kudus Kloof Formation bordering the Sundays River Valley as well as downwasted surface gravels of the "Blue Water Bay" facies, relicit patches of Nanaga Formation aeolian sands, calcrete hardpans and various soils. Previous academic and palaeontological impact assessment studies in the broader Grassridge Plateau region suggest that, while rich pockets of shelly fossil remains occur here in both the Sundays River and Alexandria Formations, the area is generally of low palaeontological sensitivity due to poor bedrock exposure *plus* weathering and leaching or calcretisation of near-surface sediments.

Recent field studies in the Bayview Wind Farm project area have recorded (1) several scientifically-important fossil sites (*e.g.* intact marine molluscs, shelly hash, petrified wood, trace fossils) within small exposures of Sundays River beds located along the margins of incised dry valleys, especially on farm Ebb and Vloed 230, as well as (2) very sparse, poorly-preserved shells within the highly calcretised Alexandria Formation on the Grassridge Plateau (*e.g.* Steins Valley 202) (See Appendix 1). None of these sites lies directly within the proposed development footprint. The younger superficial sediments are very sparsely fossiliferous, at most (*e.g.* rare rounded clasts of petrified wood reworked from the Karoo Supergroup found in surface gravels, as well as flaked stone artefacts within Pleistocene Nanaga aeolianites).

It is concluded that, *without* mitigation, the overall impact significance of the proposed wind farm development is *LOW (negative)*. Confidence levels for this assessment are rated as *moderate*. Should the recommended mitigation measures for the construction phase of the wind farm – as outlined in the Chance Fossil Finds Procedure (Appendix 2) - be fully implemented, the impact significance of the

project is still likely to remain *LOW (negative)*. However, in this case any small residual impacts due to loss of fossil heritage would be partially offset by the *positive* impact represented by an improved palaeontological database for the Grassridge region as a direct result of appropriate mitigation. There is no preference on palaeontological heritage grounds for any specific infrastructure layout option under consideration (*e.g.* location of on-site switching station, O&M buildings). For the No-Go Alternative (*i.e.* no wind farm development), impacts on local fossil heritage would be essentially *neutral to slightly beneficial*. Taking into consideration several other existing or proposed wind energy developments in the region which impact similar bedrocks and fossil assemblages, the cumulative impacts of these together with the Bayview Wind Farm and its grid connection are assessed as low (negative).

There is no objection on palaeontological heritage grounds to authorisation of the proposed Bayview Wind Farm, *provided that* the recommended monitoring and mitigation measures are implemented (Section 7.5). Given (1) the low palaeontological sensitivity of the great majority of the Bayview Wind Farm project area, and (2) the fact that direct impacts on recorded sensitive fossil sites in the area are not anticipated, no specialist palaeontological monitoring or mitigation is recommended here for this project, pending the potential discovery of significant new fossil remains during the construction phase.

The suitably qualified & experienced Environmental Control Officer (ECO) responsible for the construction phase of the wind farm development should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. Several known sensitive fossil sites lying outside the proposed development footprint but within the wind farm project area (those outlined with yellow dotted ellipses in satellite map Fig. 43 herein) should be safeguarded from damage or disturbance during the construction phase (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

During the construction phase all major clearance operations and deeper (> 1 m) excavations (*e.g.* for new access roads, turbine placements) should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible. This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the proponent's expense. These recommendations are summarized in the tabulated Chance Fossil Finds Procedure appended to this report (Appendix 2).

The palaeontologist concerned with any mitigation work will need a valid fossil collection permit from ECPHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by SAHRA (2013).

These monitoring and mitigation recommendations are to be incorporated into the Environmental Management Programme (EMPr) for the Bayview Wind Farm. The operational and decommissioning

phases of this development are unlikely to have further significant impacts on palaeontological heritage and no additional recommendations are made in this regard (The Chance Fossil Finds Procedure still applies).

Bayview Wind Farm grid connection

Four route options for a new 132 kV or 220 kV overhead powerline connecting the Bayview Wind Farm on-site switching station to the National Grid *via* the existing Grassridge, Brakrivier or Dedisa Substations are under consideration. Given (1) the shortness of the powerline, (2) the small-scale excavations required for pylon footings and access roads and (3) the low palaeontological sensitivity of the great majority of the powerline corridor sectors concerned, it is concluded that the impact significance of all four grid connection options under consideration is *LOW (negative).* The direct line to the Grassridge Substation has the lowest impact significance while the loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL has the highest impact significance. However, there is no marked preference for any particular grid connection option on palaeontological heritage grounds.

No specialist palaeontological monitoring or mitigation for the construction phase of the Bayview Wind Farm grid connection is recommended here, *provided that*:

- the proposed Chance Fossil Finds Procedure (Appendix 2) is fully implemented;
- Loc. 197 on Ebb and Vloed 230 (Fig. 43) is safeguarded during the construction phase, if the loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL powerline route is chosen (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

These recommendations should be included within the Environmental Management Programme for the proposed wind farm grid connection.

1. Introduction, project outline and brieF

The proposed Bayview Wind Farm is to be established on the land parcels Ebb & Vloed, Remaining Extent of 8/230 (835 ha), Olifantskop RE/201 (1078 ha) and Steins Valley 4/202 (900 ha), situated on the western side of the Sundays River some 25 km northeast of Uitenhage in the Uitenhage District, Eastern Cape (Figs. 1 & 2). The main affected land parcels, with a total area of 2 636 ha, are at present largely zoned for Agriculture.

The Bayview Wind Farm will have a maximum generating capacity of 135 MW. Forty-seven (47) turbine locations have been assessed. However, it is anticipated that only a maximum of forty-five (45) wind turbines will be constructed with an output capacity between 3 MW and 4 MW *per* turbine. Additional infrastructure relevant to the present palaeontological heritage assessment includes the following main components (See Figs. 42 to 44):

- main access road (10 m width), internal access roads (608 m width) and maintenance tracks (existing roads will be used as far as practically possible);
- turbine hardstands and platforms (*c.* 500 – 1000 m^3 excavation *per* turbine);

- temporary construction hardstand area (assembly area, storage area of approximately 15 ha);
- temporary construction laydown area (approximately 6 ha);
- underground electrical cabling linking turbines;
- on-site switching station (*c*. 1 ha footprint) (2 site options);
- operational and maintenance (O & M) buildings (2 site options);
- 132 kV or 220 kV overhead grid connection power line to the Eskom grid (See Section 7.6, Figs. 45 & 46).

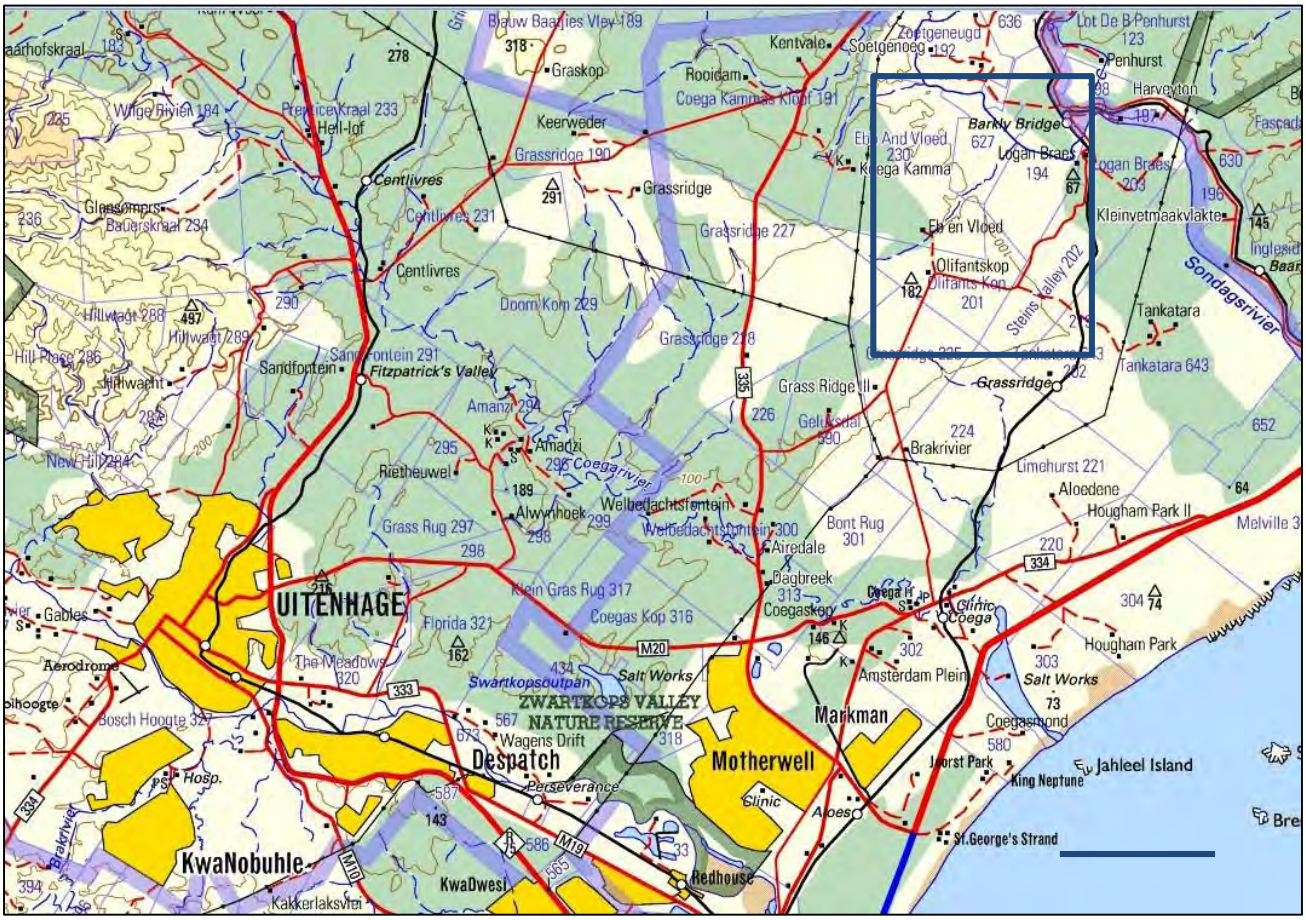

Figure 1. Extract from 1: 250 000 topographical sheet 3324 Port Elizabeth (Courtesy of the Chief Directorate: National Geo-Spatial Information, Mowbray) showing the approximate location of the Bayview Wind Farm study area to the west of the Sundays River Valley *c*. 25 km NE of Uitenhage, Uitenhage District, Eastern Cape (blue rectangle). Scale bar = 5 km.

The present palaeontological heritage impact assessment report (PIA) contributes to the muliti-disciplinary heritage assessment for the Bayview Wind Farm. It forms part of a comprehensive EIA for the alternative energy project which is being co-ordinated by EOH Coastal & Environmental Services, Port Elizabeth (Contact details: Mrs Kim Brent, EOH Coastal & Environmental Services, 13 Stanley Street; Richmond Hill, Port Elizabeth, Eastern Cape, South Africa 6070. Tel: +27 (41) 585 1715. Fax: 086 604 8781. Cell: +27 (79) 5111032. E-mail: kim.brent@eoh.co.za).

The Draft PIA available for a thirty (30) day Public Review period, as part of the Public Participation Process (PPP) on the Draft Environmental Impact Report (EIR), from the 20th of August 2018 until the 20th of September 2018. The comments, which were received, relating to paleontological impact assessment have been included in the Issues and Response Trail (IRT) in the Final EIR and, where necessary, responses were provided by the relevant specialist.

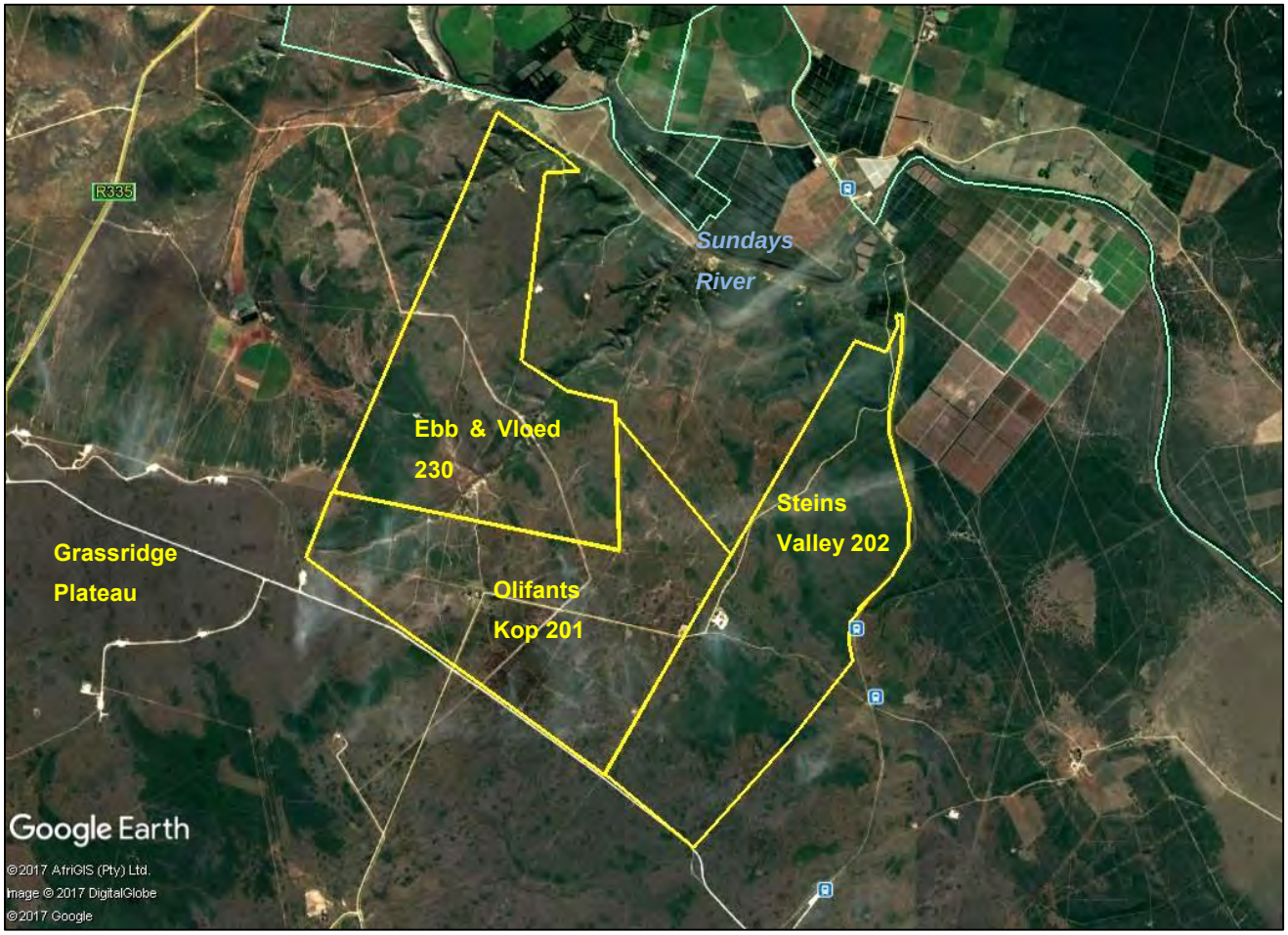

Figure 2. Google earth© satellite image of the Bayview Wind Farm study area (yellow polygons) situated on the south-western side of the Sundays River Valley, *c*. 25 km NE of Uitenhage. The area lies towards the inner (landward) edge of the Grassridge Plateau which is dissected here by several shallow, largely dry, dendritic palaeovalleys incised by tributary streams of the Sundays River.

Figure 3. The formally-recognised Stratotype Section of the Early Cretaceous Sundays River Formation along steep riverine cliffs of the Sundays River Valley, Farm Zoetgeneugd 192, situated *c*. 2 km NW of the Bayview Wind Farm project area. This region is well known for its Early Cretaceous fossils.

Figure 4. Limited erosion gulley exposure of Sundays River Formation bedrocks along densely thicketed dry valley slopes on Ebb & Vloed 230 (Loc. 234).

Figure 5. Typical flat-lying terrain on the Grassridge Plateau with dispersed quartzitic surface gravels ("Blue Water Bay" facies) and calcrete rubble exposed in less vegetated areas.

Figure 6. Rounded grassy areas with dark, organic-rich soils and sparse gravels are generally associated with hidden solution hollows (*dolines*) etched into calcretes of the Alexandria Formation.

2. Study approach and sources

This combined desktop and field-based PIA report provides an assessment of the observed or inferred palaeontological heritage within the Bayview Wind Farm study area, with recommendations for specialist palaeontological mitigation where this is considered necessary. The report is based on (1) a review of the relevant scientific literature, including previous palaeontological impact assessments in the area (*e.g.* Almond 2010, 2011, 2012, 2013, Gess 2017), (2) published geological maps and accompanying sheet explanations, (3) a four-day field study of the consolidated Bayview Wind Farm study area (6-9 November 2017) and the resulting palaeontological heritage scoping report (Almond 2017), as well as (4) the author's extensive field experience with the formations concerned and their palaeontological heritage (Almond *et al.* 2008). Tabulated notes on numbered geological and palaeontological localities, together with GPS locality data, are provided in Appendix 1.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations, *etc.*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following scoping during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (provisional tabulations of palaeontological sensitivity of all formations in the Eastern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond *et al.* 2008) and are shown on the palaeosensitivity map on the SAHRIS (South African Heritage Resources Information System) website. The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most notably the extent of fresh bedrock excavation and ground clearance envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted.

The focus of palaeontological field assessment is *not* simply to survey the development footprint or even the development area as a whole (*e.g.* farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more representative exposures of all the sedimentary rock units present (*N.B.* Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (*e.g.* formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the field study where they are well-represented in the study area. It is normal practice for impact palaeontologists to collect representative, well-localised (*e.g.* GPS and stratigraphic data) samples of fossil material during field assessment studies. In order to do so, a fossil collection permit from SAHRA is required and all fossil material collected must be properly curated within an approved repository (usually a museum or university collection).

Note that while fossil localities recorded during field work within the study area itself are obviously highly relevant, most fossil heritage here is embedded within rocks beneath the land surface or obscured by surface deposits (soil, alluvium *etc*) and by vegetation cover. In many cases where levels of fresh (*i.e.* unweathered) bedrock exposure are low, the hidden fossil resources have to be *inferred* from palaeontological observations made from better exposures of the same formations elsewhere in the region but outside the immediate study area. Therefore a palaeontologist might reasonably spend far *more* time examining road cuts and borrow pits close to, but outside, the study area than within the study area itself. Field data from localities even further afield (*e.g.* an adjacent province) may also be adduced to build up a realistic picture of the likely fossil heritage within the study area.

On the basis of the desktop and field studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological and taphonomic data) – is usually most effective during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority, the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za). It should be emphasised that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

3. Assumptions and limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerised database of fossil collections in major RSA institutions which can be consulted for impact studies.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist, as in the case of the present study.

In the case of the Bayview Wind Farm study area bedrock exposure is highly constrained by extensive superficial deposits (*e.g.* calcretes, soils, gravels, aeolian sands), especially in areas of low relief, as well as by dense thicket and grassy vegetation. The study area is extensive and for the most part fairly flat, with some gentle hillslopes and drainage lines but few access roads (Fig. 2). However, sufficient bedrock exposures were examined during the course of the four-day field study to assess the palaeontological heritage sensitivity of the main rock units represented within the wind farm study area. Comparatively few academic palaeontological studies have been carried out hitherto in the region, so any new data from impact studies here are of scientific interest. Palaeontological and geological data from the recent field study is usefully supplemented by those from several other field-based fossil heritage impact studies carried out in the Grassridge Plateau region by the author and other palaeontologists in recent years (See reference list). Confidence levels for this impact assessment are consequently rated as MODERATE, despite the unavoidable constraints of limited exposure, time and access.

4. Legislative context

The present combined desktop and field-based palaeontological heritage report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPr for this project.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

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

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013) and are currently under revision.

5. Geological context

The Bayview Wind Farm project area is located some 10 km inland from the Algoa Bay coast on the flat-lying to gently-sloping Grassridge Plateau which builds the inner portion of the coastal platform to the northeast of Uitenhage, between the Coega and Sundays Rivers (Goedhardt & Hattingh 1997) (Fig. 1). In the northeast the plateau is incised by several small stream palaeovalleys (mostly dry at present) leading down into the Sundays River Valley (Fig. 2). The vegetation on the plateau is grassy to shrubby *bontveld*, with denser thicket on steeper valley slopes (Figs. 4 & 5). Satellite images show several small, rounded pans or *dolines* (solution hollows) on the plateau which are associated with dark, organic-rich soils, grassy vegetation and dispersed quartzitic pebbles (Fig. 6). Bedrock exposure levels are generally low in the Grassridge Plateau region as a whole due to dense thicket or grassy vegetation and superficial sediment cover (*e.g.* calcretes, surface gravels, aeolian sands and soils.

The geology of the Bayview Wind Farm project area is outlined on 1: 250 000 geology sheet 3324 Port Elizabeth as well as in more detail on 1: 50 000 geology sheet 3325DA Addo (Toerien & Hill 1989, Le Roux 2000) (Fig. 7). The marine-planed Grassridge Plateau is cut across Early Cretaceous **Sundays River Formation** (**Uitenhage Group**) (Ks, red, in Fig. 7). The Sundays River Formation comprises a thick (up to 2 km) succession of thin-bedded grey sandstones, siltstones and finer-grained mudrocks that are often highly fossiliferous (Shone 2006, Almond 2010). Depositional settings range from estuarine through littoral (shoreline) to marine outer shelf (McMillan 2003). These Cretaceous mudrocks and subordinate sandstones crop out extensively in the south-western portion of the study area as well as along several small incised stream valleys running north-eastwards into the Sundays River Valley, notably on farm Ebb and Vloed 203. It is noted that a key Stratotype Section for the Sundays River Formation has been selected along spectacular riverine cliffs on the farm Zoetgeneugd 192, situated only about 2 km northwest of the present study area (Reddering, unpublished SACS report) (Fig. 3). In practice, most of the Sundays River Formation outcrop within the study area is obscured by thicket and younger superficial sediments. Limited exposures of grey-green siltstones and ochreous-weathering, tabular sandstones are encountered along the margins of dry valleys, especially close to the Sundays River, where they are often highly fossiliferous (Section 6) (Figs. 3 to 14).

On the higher-lying part of the Grassridge Plateau, such as on farms Olifants Kop 201 and Steins Valley 202, the Sundays River beds are unconformably overlain by the thin (10 m or less), limestone-dominated, shallow marine to coastal **Alexandria Formation** (**Algoa Group**) (Ta, pink in Fig. 7). This estuarine to littoral marine formation consists of a basal conglomerate, locally rich in oyster shells, overlain by calcareous sandstones, shelly coquinas and thin conglomerates (Figs. 15 & 16). It represents a composite product of several marine transgressions (marine invasions) and regressions (marine retreats) across the Algoa coastal plain in Late Miocene-Pliocene times, *i.e*. roughly 7-5 Ma ago (Maud & Botha 2000, Roberts *et al.* 2006). Over large areas the Alexandria Formation is blanketed by pebbly, reddish-brown residual soils and gravels that infill solution hollows in the underlying calcretes (pale yellow with coarse stipple on Fig. 3) (Figs. 7 & 17). These downwasted residual pebbly deposits were previously (1: 250 000 geology map) assigned to a separate **Blue Water Bay Formation** but are now incorporated into the Alexandria Formation, from which they were derived by weathering and downwasting (1: 50 000 map). They are referred to as “Blue Water Bay” facies in this report. Some areas mapped as Blue Water Bay Formation may rather be high level terrace gravels of the Kudus Kloof Formation, or a composite of the two.

Relict patches of Plio-Pleistocene aeolianites (wind-blown dune sands) of the **Nanaga Formation** (Algoa Group) are scattered across the interior coastal plateau, possibly underlying many otherwise featureless areas, but many of these are concealed by vegetation and are not separately mapped. Examples were encountered along the margins of the Sundays River Valley as well as along dry river valleys in the interior (Figs. 9, 23 & 24). In both cases the rubified sandy deposits are associated with dispersed, fresh-looking quartzite stone artefacts supporting a Pleistocene age. Calcrete hard pans capping the rubified sands (Figs. 9 & 23) are encountered at significantly lower elevations than the Miocene – Pliocene Alexandria Formation calcretes of the Grassridge Plateau and are correspondingly younger in age (probably Pleistocene).

Along the south-western flank of the Sundays River Valley, in the north-eastern part of the study area, the older Cretaceous and Tertiary bedrocks are planed off by a composite, stepped, river-cut pediment surface that is mantled with ancient alluvial terrace gravels ("High Level Gravels"; pale yellow with red stipple, T-Qk in Fig. 7). The alluvial terrace deposits of Miocene to Holocene age bordering the Sundays River have been grouped into the **Kudus Kloof Formation** by Hattingh (1994, 2001). According to the detailed map of Hattingh (2001, Appendix 2; Fig. 8 herein), the terrace deposits in the Bayview Wind Farm study belong to Terraces 4 to 8 of inferred Early to Late Pliocene age (*c*. 5 to 2.5 Ma). Pebbly to cobbly unconsolidated surface gravels overlying calcrete over large portions of the study area may represent a composite of Kudus Kloof terrace gravels as well as reworked downwasted clasts from the Alexandria Formation ("Blue Water Bay" facies) (Figs. 18 & 21). Younger, predominantly fine-grained alluvial deposits of Pleistocene to Holocene age are represented along the banks of the Sundays River as well as on the flanks of some dry river valleys in the interior (Fig. 22). A prominent-weathering bench of calcareous-cemented quartzitic gravels and reworked sandstone blocks encountered in the northern portion of Ebb and Vloed 203, where it sharply overlies weathered Sundays River Formation beds, is also assigned here to the Kudus Kloof Formation (Figs. 9, 19 & 20). It is probably Pliocene in age (*cf* Hattingh 2001).

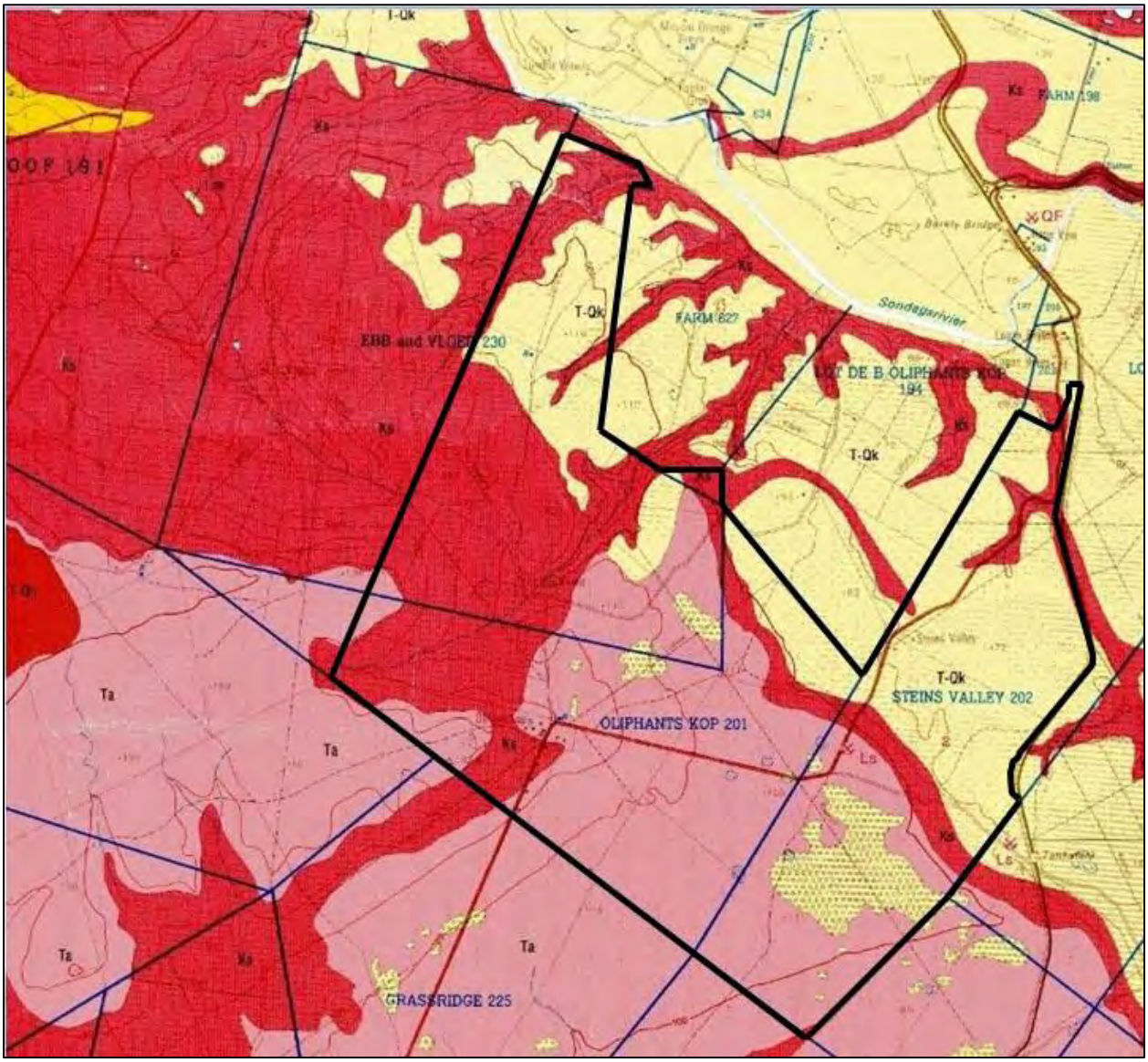

Figure 7. Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria). The Bayview Wind Farm study area (black polygon) is underlain at depth by Early Cretaceous sediments of the estuarine to marine Sundays River Formation (Ks, red). They are capped in the higher-lying parts of the Grassridge Plateau by Neogene (Late Tertiary) shallow marine to coastal limestones and conglomerates of the Alexandria Formation (Ta, pink). Residual "Blue Water Bay" type pebbly soils overlie parts of the Alexandria Formation outcrop area (pale yellow with coarse stipple). Pliocene – Pleistocene alluvial gravels of the Kudus Kloof Formation (T-Qk, pale yellow with fine stipple) mantle a series of river-cut terraces along the south-western flanks of the Sundays River Valley (and perhaps also some of the areas mapped as Blue Water Bay Formation). For palaeontological sensitivity mapping purposes, Ks (red) = HIGH SENSITIVITY, Ta (pink) = MODERATE TO LOW SENSITIVITY and yellow areas (*e.g.* T-Qk) = LOW SENSITIVITY.

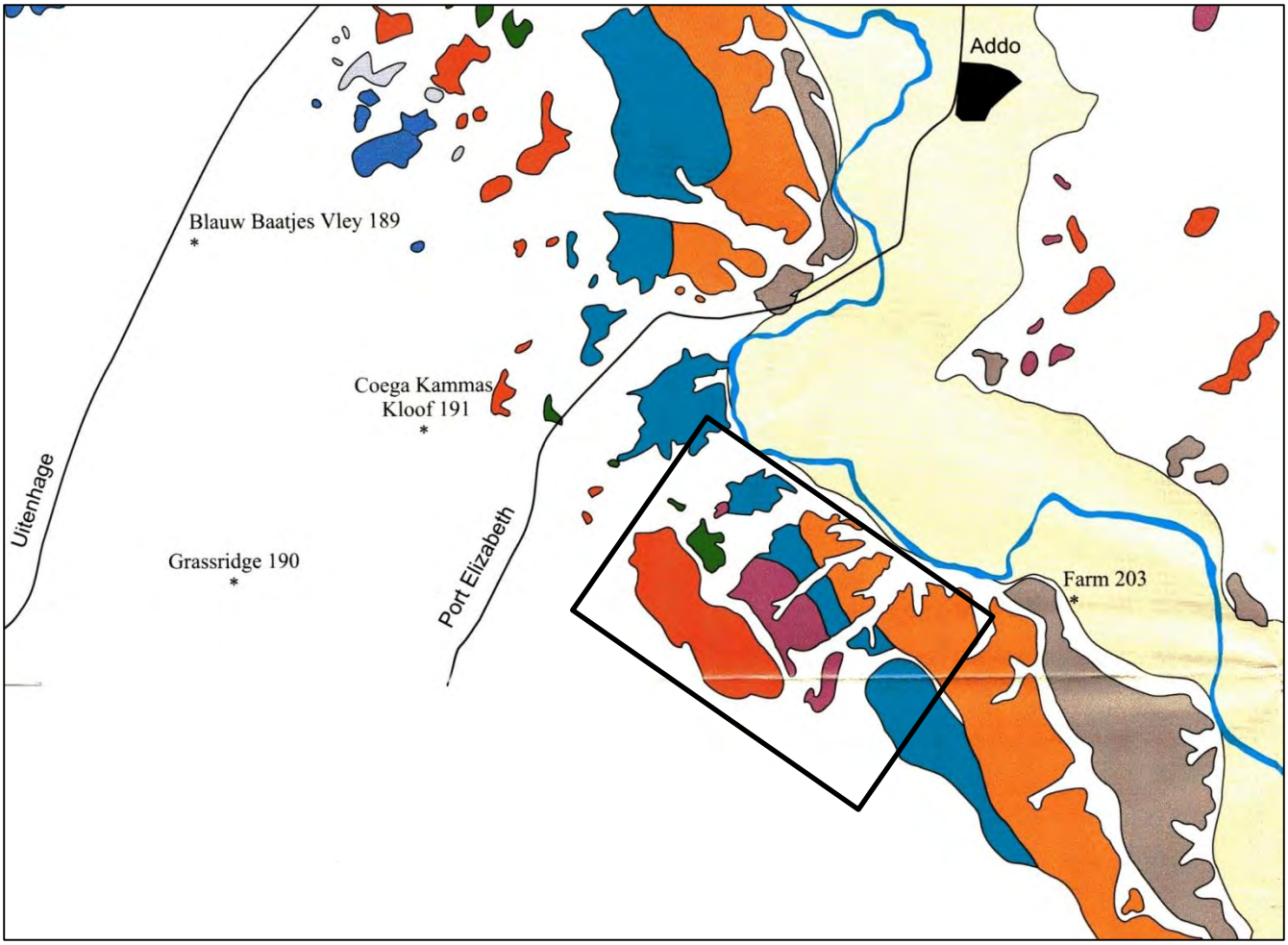

Figure 8. Late Caenozoic alluvial terrace deposits of the Kudus Kloof Formation mapped by Hattingh (2001) in the Bayview Wind Farm study region (black rectangle). Terraces 4 (red), 5 (green), 6 (purple) , 7 (blue) and 8 (orange) - in order of decreasing age and elevation above modern river level - are recognised here, ranging in estimated age from Early to Late Pliocene. Some of the older gravels may have been previously mapped as Blue Water Bay Formation.

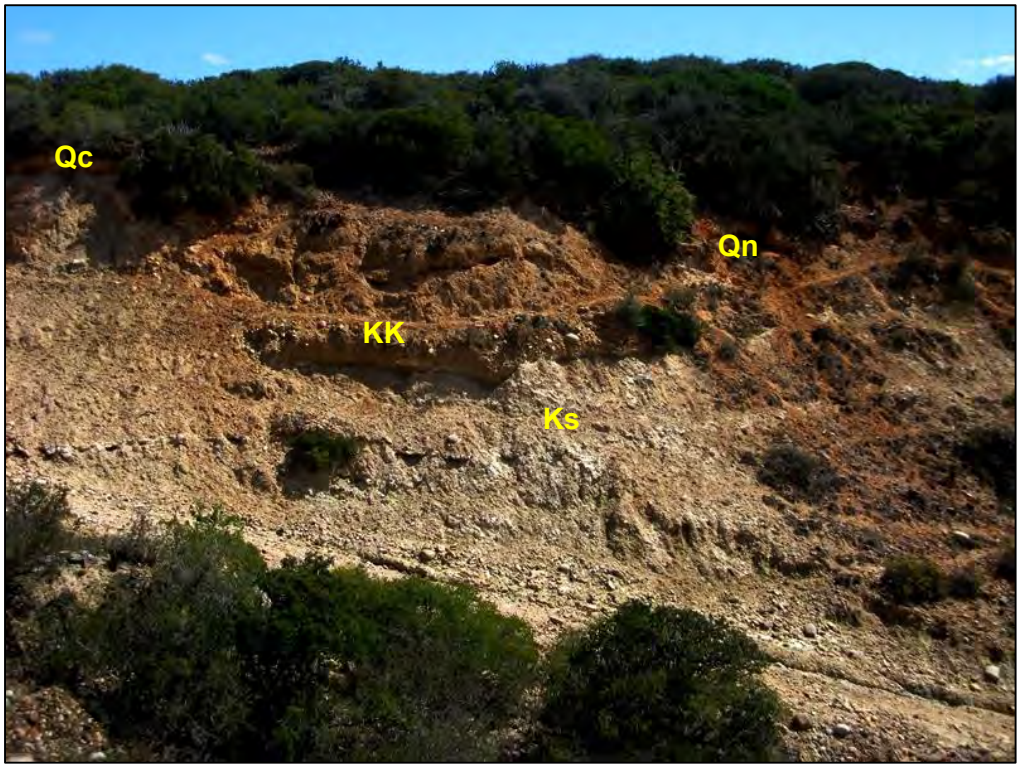

Figure 9. Erosion gulley on Ebb & Vloed 230 showing grey-green weathered Sundays River Formation beds (Ks) truncated by a well-cemented calcareous conglomerate – probably Pliocene Kudus Kloof Formation terrace gravels (KK), orange-brown sandy to gravelly alluvium / reworked aeolianites (Nanaga Fm. / Kudus Kloof Fm., Qn) and Pleistocene calcrete capping (Qc) (Loc. 224).

Figure 10. Gulley exposure of interbedded, tabular ochreous sandstones and grey-green siltstones of the Sundays River Formation, Ebb & Vloed 230. Arrow indicates a prominent-weathering calcified hardground with shelly fossil moulds (Loc. 232).

Figure 11. Dark-weathering, gritty to gravelly tabular sandstones of the Sundays River Formation exposed along an escarpment edge on Olifants Kop 201 (Loc. 197) (Hammer = 30 cm).

Figure 12. Fresh fractured surface through gritty sandstones seen in the previous figure showing oligomict, subrounded grains of sandstone, quartzite, kaolinite and ferruginised material (largest grain seen here is 3 cm long) (Loc. 197).

Figure 13. Prominent-weathering, greenish-brown, tabular shelly sandstones of the Sundays River Formation, Ebb & Vloed 230 (Loc. 212) (Hammer = 30 cm).

Figure 14. Weathered, horizontally-laminated sandstone of the Sundays River Formation with large, darker-hued lenticular calcareous concretions within it – these are often associated with concentrations of shelly fossils (Hammer = 30 cm) (Loc. 208).

Figure 15. Calcretised conglomerates and grey to pinkish calcareous aeolianites of the Alexandria Formation exposed in a borrow pit cut face, Steins Valley 202 (Loc. 184) (Hammer = 30 cm). This borrow pit is not part of the wind farm project.

Figure 16. Thick calcretised calcarenites of the Alexandria Formation overlying weathered Sundays River Formation along an escarpment edge on Olifants Kop 201 (Loc. 197) (Hammer = 30 cm). Note enclosed dark, angular reworked blocks of Sundays River sandstones.

Figure 17. Brownish pebbly to bouldery gravels of the "Blue Water Bay" facies infilling solution hollows etched into Alexandria Formation calcarenites, Ebb & Vloed 230 (Loc. 208)

Figure 18. Typical oligomict, pebbly to bouldery downwasted gravels of the "Blue Water Bay" facies mantling substantial areas of the Alexandria Formation on the Grass Ridge Plateau, here on Steins Valley 202 (Loc. 189) (Hammer = 30 cm). Note occasional reddened clasts.

Figure 19. Prominent bench of well-cemented cobbly conglomerates – probably of the Pliocene Kudus Kloof Formation – erosionally overlying weathered Sundays River Formation saprolite, Ebb & Vloed 230 (Hammer = 30 cm) (Loc. 225). See Figure 9 for stratigraphic context.

Figure 20. Imbricated blocks of tabular Sundays River Formation sandstone incorporated into the Kudus Kloof Formation, Ebb & Vloed 230 (Loc. 225).

Figure 21. Dense blanket of pebbly to cobbly surface gravels mapped as the Kudus Kloof Formation, possibly with an admixture of reworked "Blue Water Bay" material , Ebb & Vloed 203 (Loc. 207).

Figure 22. Massive ochreous silty to sandy alluvium with thin pebbly lenses exposed in banks of a dry valley on Ebb & Vloed 203 (Loc. 213).

Figure 23. Semi-consolidated, orange-brown sands of probable aeolian origin (possibly Nanaga Formation) with network of calcrete veins and calcrete hardpan capping (Hammer = 30 cm), Ebb & Vloed 230 (Loc. 219). These sands contain fresh quartzite stone artefacts of probable Pleistocene age.

Figure 24. Unconsolidated, rubified sands with dispersed quartzite blocks and flakes – probably a relict patch of Nanaga Formation Pleistocene aeolianites, Steins Valley 202 (Loc. 193) (Hammer = 30 cm).

6. Palaeontological heritage

The fossil record of the sedimentary rock units represented within the Bayview Wind Farm study area have been outlined in the palaeotechnical report for the Eastern Cape by Almond *et al.* (2008) and extensively reviewed for several palaeontological heritage assessments carried out in the Coega – Grassridge region by the present author and others (*e.g.* Almond 2010, 2011, 2012, 2013, Gess 2017).

The **Sundays River Formation** (Uitenhage Group) contains one of the most prolific and scientifically important marine biotas of Mesozoic age in southern Africa (See Almond 2010 and refs. therein for a fairly recent overview). Key historical fossil sites along the Sundays River Valley in the vicinity of Barkly Bridge – some of which lie within the present study area - are mapped by McLachlan & McMillan (1976) (See also Cooper 1981, 1991 for the molluscan fauna). They include a range of shelly marine invertebrates, such as ammonites, bivalves and other molluscs, as well as rare dinosaur remains. In particular, a range of molluscan taxa as well as serpulid worm tubes are reported from key Sundays River Formation exposures fronting the major westward bend in the Sundays River on adjoining Farms Zoetgeneugd 192 (the Stratotype locality for this formation; Fig. 3) and Ebb and Vloed 230 (Fig. 25).

Where the Sundays River Formation is well-exposed in the Bayview Wind Farm the sandstone facies are often associated with locally abundant shelly debris (*coquinas*) of possible tempestite and debris

flow origin as well as well-preserved, articulated or disarticulated mollusc shells. These mainly comprise a range of bivalves – most notably large, thick-shelled and ribbed shells of trigoniids (*e.g. Megatrigonia, Steinmanella*), small, high-spired gastropods, rare straight-shelled ammonoids (*Bochianites*) as well as possible terebratulid brachiopods, small encrusting oysters and serpulid worms (Figs. 26 to 35). Most of the *in situ* trigoniids, with a few exceptions, are not in life position and preserve the original thick, strongly-ornamented shell. Concentrations of mainly disarticulated bivalves – preserved as mould or intact valves - along bedding planes of calcified sandstone may represent hardgrounds (resistant, early-cemented sea floor horizons) (Fig. 10). Dark sphaeroidal to lenticular calcareous concretions within the sandstone facies may contain highly-comminuted shelly debris, intact small shells, angular blocks of woody axes as well as a hash of tiny wood fragments, some of which remarkably retain a loose, fibrous character (Figs. 35 & 36). Low diversity trace fossil assemblages – mainly indeterminate subcylindrical burrows – are associated with calcareous sandstone lenses as well siltstone facies; in the latter case they are calcretised and superficially resemble root casts (rhizoliths) (Figs. 37 and 38).

The **Alexandria Formation** (Algoa Group) is known for its rich shelly marine fauna of Miocene – Pliocene invertebrates (Le Roux 1987a, 1987b, 1993). However, over much of the Coega – Grassridge Plateau these lime-rich sediments have been heavily calcretised, leached and otherwise modified by diagenesis so that they now often contain little or no well-preserved fossil material (Almond 2010, 2011). Many of the original shelly remains have been dissolved and are preserved as moulds. Lenses of coquinite (shell hash) and pebbly conglomerate beds with fragmentary to intact fossil shells – mainly oysters (*Crassostrea*) or large, thick-shelled gastropods (*e.g.* cowries) and bivalves (*Glycimeris*) – are occasionally seen, however, especially towards the base of the succession. They include impressive dense fossil oyster beds and rich shelly lenses in parts of the Grassridge Plateau (*e.g.* Almond 2011, 2014, Gess 2017). A few productive fossil localities in the Coega region – mainly surface limestone quarries or borrow pits that are no longer operational - are listed by Le Roux (1987; his map Fig. 1.1) but none of these are located in or close to the present study area on the Grassridge Plateau. The rich Alexandria Formation shelly lenses illustrated by Gess (2017) on farm Welbedachtsfontein 300 lie some 8 km southwest of the Bayview Wind Farm project area. The only fossil remains recorded within the Alexandria Formation in the present study area comprise sparse, poorly-preserved thick-shelled oysters within pebbly calcarenite facies (Fig. 39).

The residual soils of the “Blue Water Bay” facies overlying the Alexandria Formation limestones are only very sparsely fossiliferous, with occasional terrestrial snails as well as robust marine shells that have weathered out of the underlying beds (Le Roux 1989, Almond 2010). Carbonaceous silty to clay-rich doline (solution hollow) infills might be associated with mammalian remains (bones, teeth, horn cores) and palynomorphs but there are no records of such fossils in this context so far (Almond 2010).

No fossils are reported from the **Kudus Kloof Formation** by Hattingh (1994, 2001); these fluvial terraces of inferred Miocene / Pliocene / Pleistocene age are dated rather by reference to correlated fossiliferous marine terraces along the coast. Such “High Level Gravels” on elevated alluvial terraces tend to be coarse and to have suffered extensive reworking (*e.g.* winnowing and erosional downwasting), but might occasionally contain valuable resistant-weathering fossils such as mammalian teeth and reworked blocks of petrified wood. Finer-grained alluvial deposits may also contain important fossil mammalian remains (*e.g.* mammal bones, teeth, horn cores) or subfossil plant material. Carbonaceous muds associated with *vlei* areas may contain peats, palynomorphs (pollens, spores) and other microfossils as well as the bones and teeth of mammals and other fauna that died in

the area. Apart from low diversity cylindrical burrow assemblages within calcretised Kudus Kloof arenites (Fig. 40) as well as isolated, well-rounded float clasts of petrified wood that have probably been reworked from the Beaufort Group in the Main Karoo Basin (Fig. 41), no fossils were recorded from Caenozoic alluvial deposits and surface gravels during the present study.

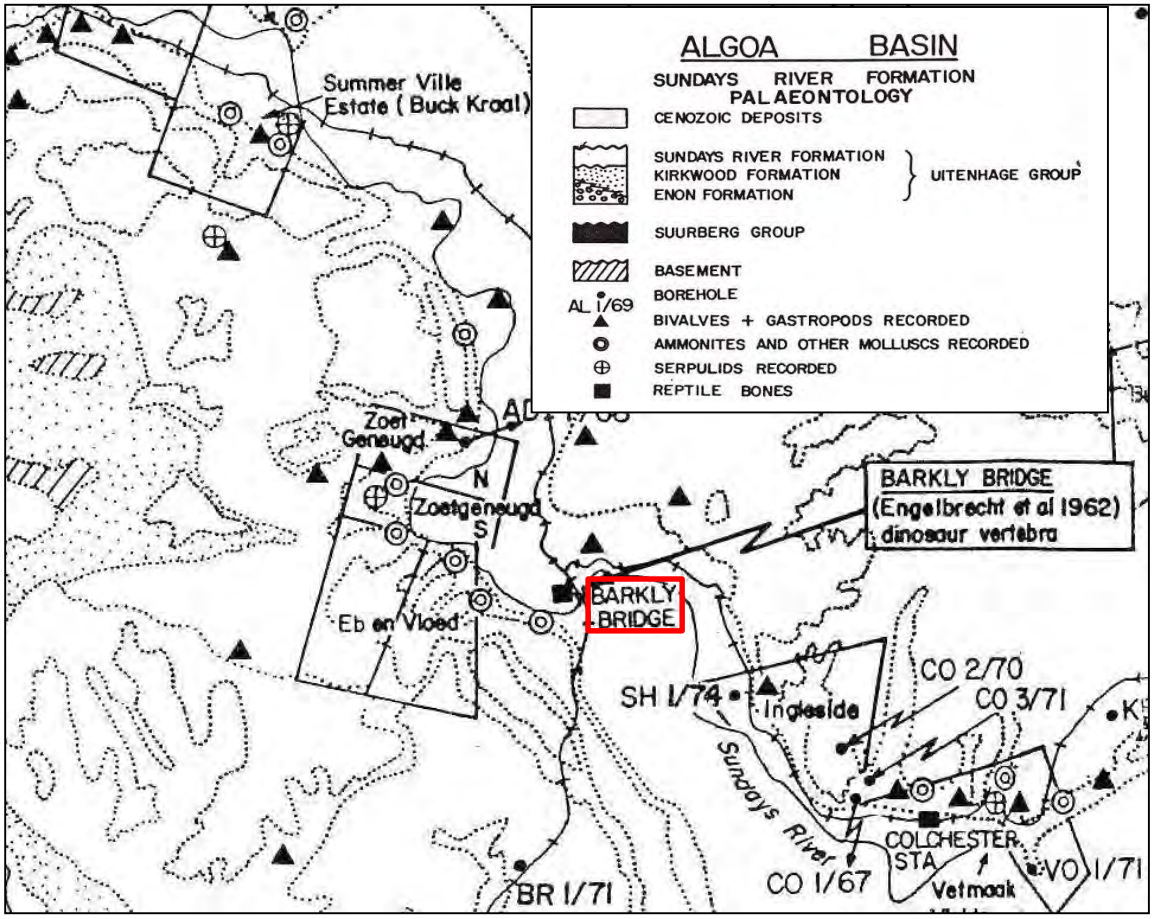

Figure 25. Early Cretaceous fossil localities in the Sundays River Formation near Barkly Bridge, Sundays River Valley. Several groups of marine invertebrates (crustaceans and molluscs, including bivalves, gastropods, belemnites and ammonites, as well as serpulid worm tubes) are reported from Sundays River Formation beds on farms just to the west of Barkly Bridge, close to or within the Bayview Wind Farm study area, while dinosaur remains are recorded from Barkly Bridge itself (Figure modified from McLachlan & McMillan 1976).

Figure 26. Sundays River Formation sandstone containing numerous embedded trigoniid bivalves in various orientations (possibly reworked by storms or debris flow), Ebb & Vloed 230 (Loc. 234) (Scale = *c*. 15 cm).

Figure 27. Block of Sundays River Formation sandstone containing coquina of disarticulated trigoniid valves that have probably been reworked by storms, Ebb & Vloed 230 (Loc. 233). Block is *c*. 40 cm long.

Figure 28. Intact and disarticulated large, heavily ornamented trigoniid bivalves (*Steinmanella*) weathered out of the Sundays River shelly sandstone bed seen in Figure 26 (Scale in cm) (Loc. 233).

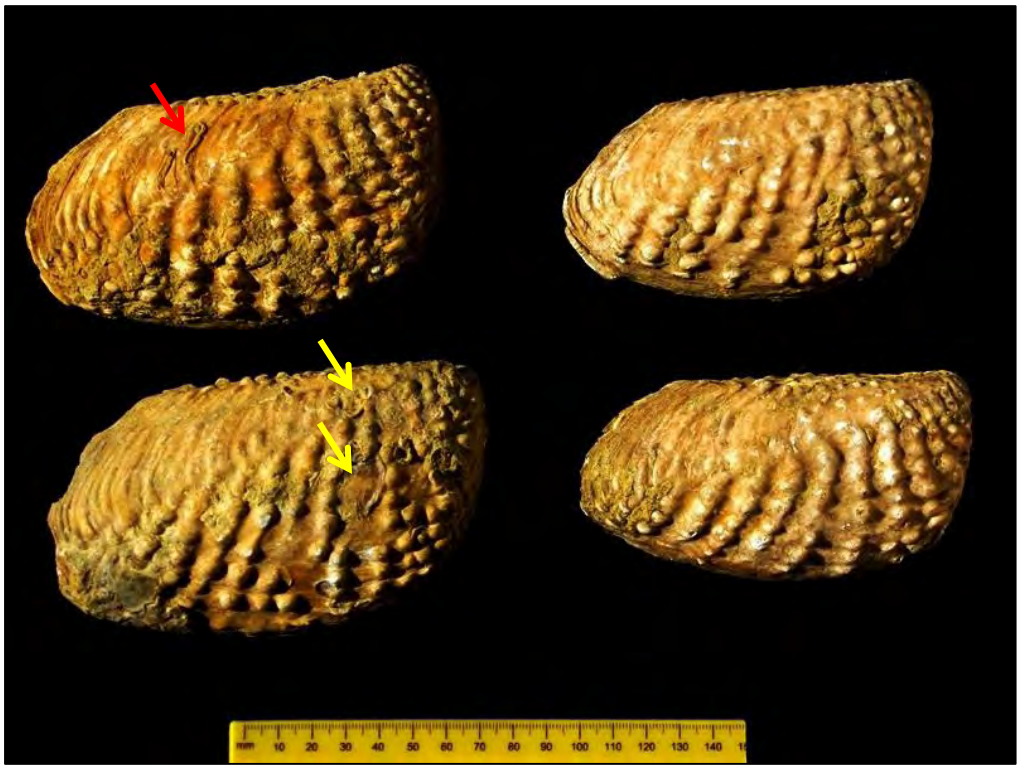

Figure 29. Cleaned specimens of the large, coarsely-tuberculate trigoniid bivalve *Steinmanella* from Loc. 233 (Ebb & Vloed 230) showing specimens encrusted with serpulid worm tubes (red arrow) and small oysters (yellow arrow) (Scale in cm).

Figure 30. Shelly coquina of intact and fragmentary, disarticulated valves of the strongly-ribbed trigoniid bivalve *Megatrigonia* within a Sundays River Formation sandstone, Ebb & Vloed (Loc. 228). The centrally-placed intact valve is *c*. 6.5 cm long.

Figure 31. Incomplete shell of the rare, delicately-ribbed, straight-shelled ammonite *Bochianites* with an elliptical cross section, Ebb & Vloed 230 (Loc. 212). As seen here, the shell is 4 cm long (including mould) and 5 mm wide.

Figure 32. Float specimen of the large, longitudinally-ribbed, conical bivalve *Pinna*, Ebb & Vloed 230 (Loc. 231) (Scale in cm).

Figure 33. Block of brownish-weathering calcareous sandstone concretion from a Sundays River Formation sandstone containing numerous well-preserved small bivalves, Ebb & Vloed 230 (Loc. 209) (Scale in cm and mm).

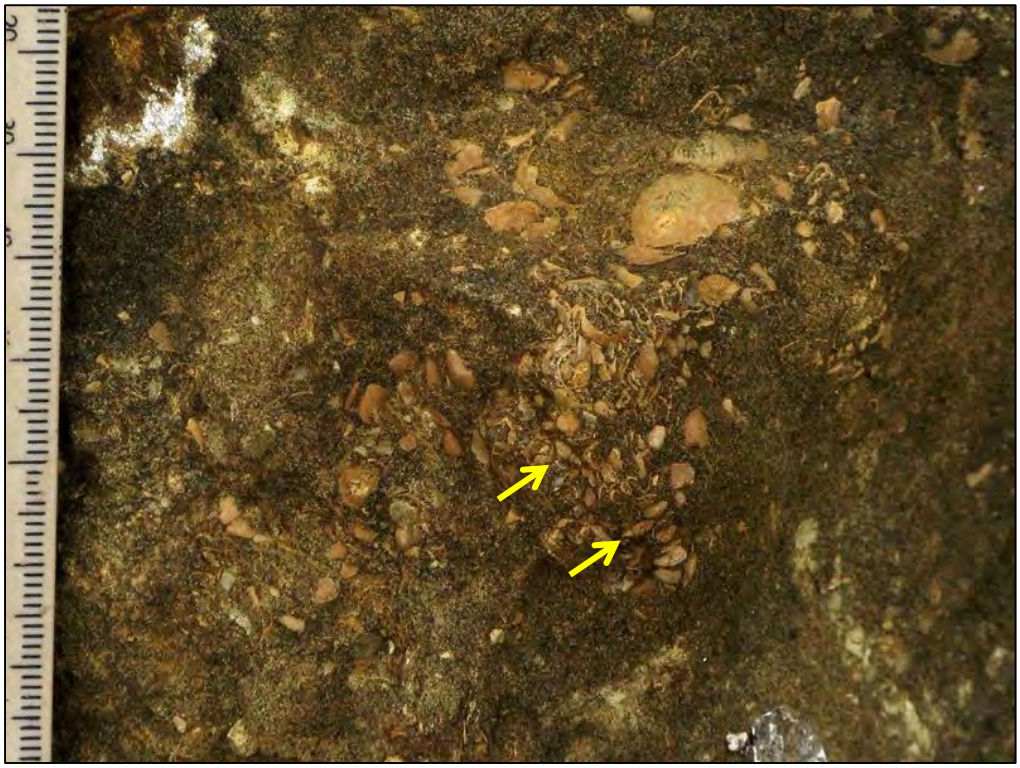

Figure 34. Fine shelly hash, including tiny high-spired gastropods (arrowed), preserved within a Sundays River Formation calcareous sandstone concretion, Ebb & Vloed 230 (Loc. 212) (Scale in mm).

Figure 35. Freshly-broken surface through a calcareous sandstone concretion from the Sundays River Formation showing slurry of well-preserved fragmentary shells, pale brown wood and black charcoal, Olifants Kop 197 (Loc. 197) (Field of view *c*. 6 cm across).

Figure 36. Fragments of substantial woody stems suspended within calcareous-cemented sandstone concretions from the Sundays River Formation, Olifants Kop 197 (Loc. 197) (Scale in cm and mm).

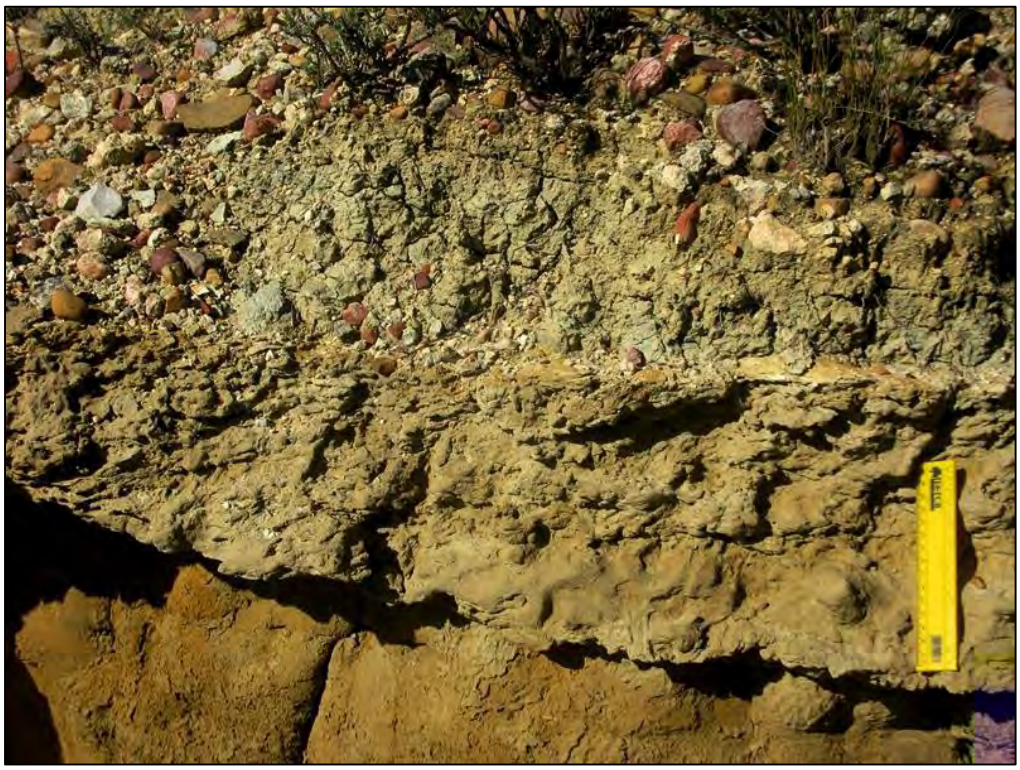

Figure 37. Densely-bioturbated lens of calcareous sandstone at the top of a Sundays River Formation sandstone package, Ebb & Vloed 230 (Loc. 232) (Scale *c*. 15 cm long).

Figure 38. Weathered Sundays River Formation siltstones with embedded calcretised, subcylindrical burrow casts, Ebb & Vloed (Loc. 208) (Scale in cm and mm).

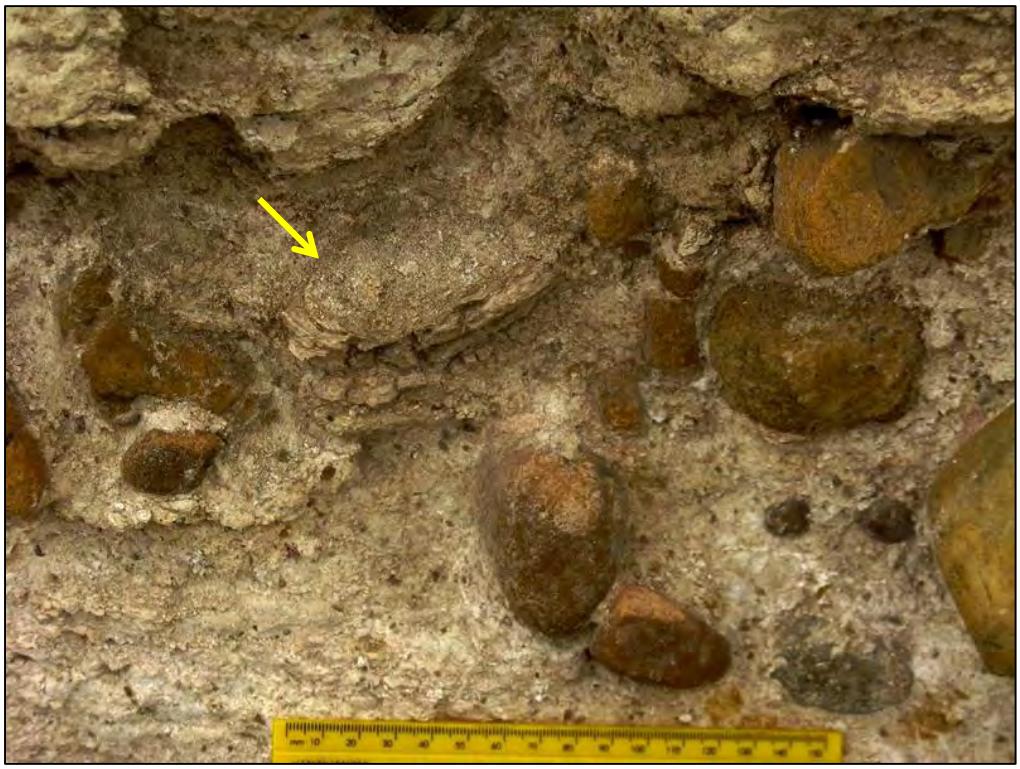

Figure 39. Poorly-preserved, thick-shelled oyster (arrowed) embedded within Alexandria Formation pebbly calcarenites, disused borrow pit on Steins Valley 202 (Loc. 184) (Scale in cm and mm).

Figure 40. Bioturbated, calcretised sandy lens (20-30 cm thick) at the base of the Kudus Kloof Formation incised into weathered Sundays River siltstones, Ebb & Vloed 230 (Loc. 225).

Figure 41. Isolated, well-rounded pebble of growth-banded silicified wood in surface float ("Blue Water Bay" facies or Kudus Kloof Formation), probably reworked long-distance from Beaufort Group (Permian) bedrocks in the Main Karoo Basin, Ebb & Vloed 214 (Loc. 214).

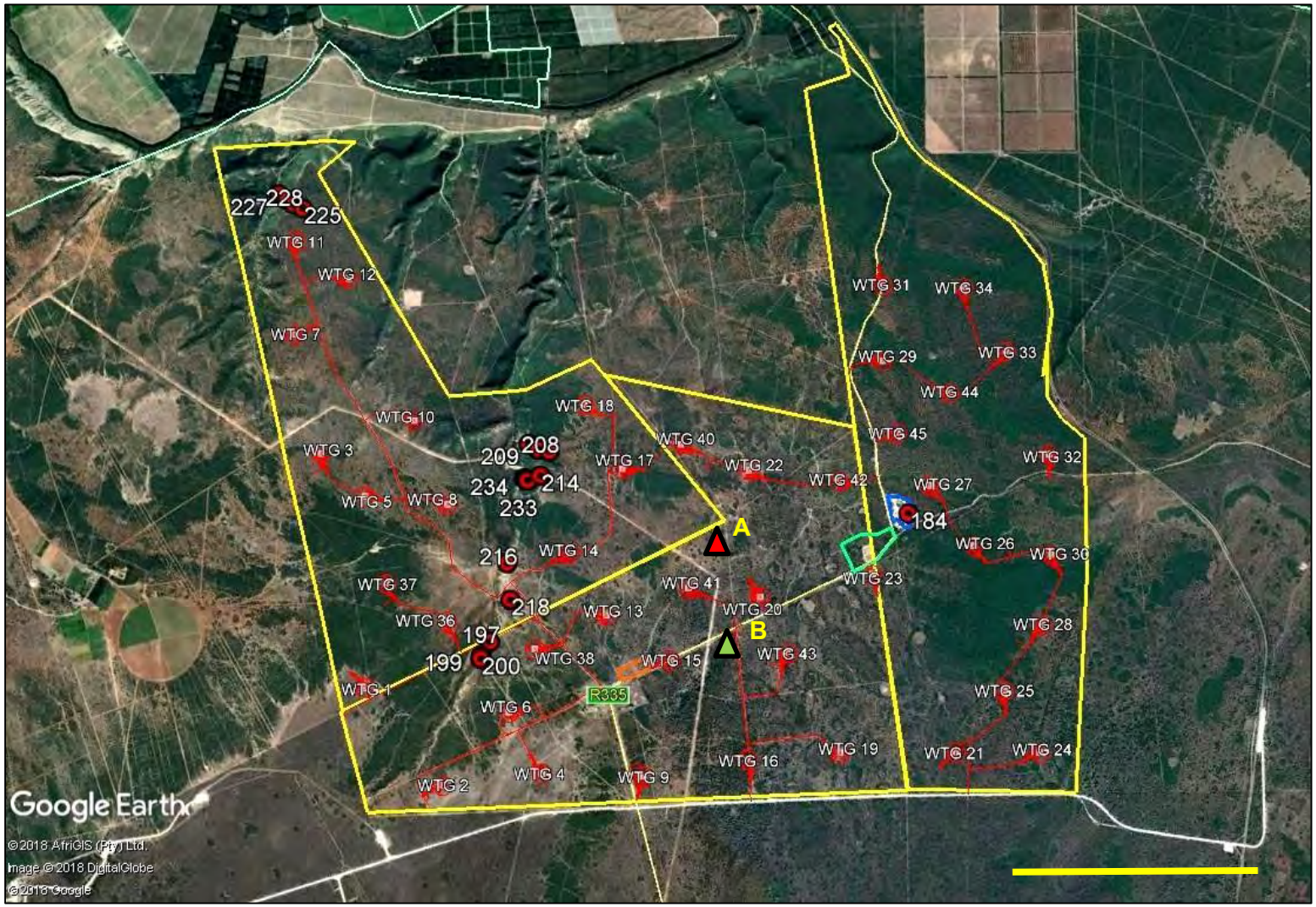

Figure 42. Google Earth© satellite image of the Bayview Wind Farm project area near Addo (yellow polygon) showing the proposed final layout (numbered WTG sites), internal access roads (red lines), temporary construction area (pale green), control office (orange), optional sites for the on-site switching station and adjacent O&M buildings (red and green triangles A & B), Numbered red circles indicate newly-identified fossil sites. The blue area is a disused borrow pit (*not* part of the wind farm project). Scale bar = 2 km. N towards top left. Please see following two figures for more detailed views of some areas.

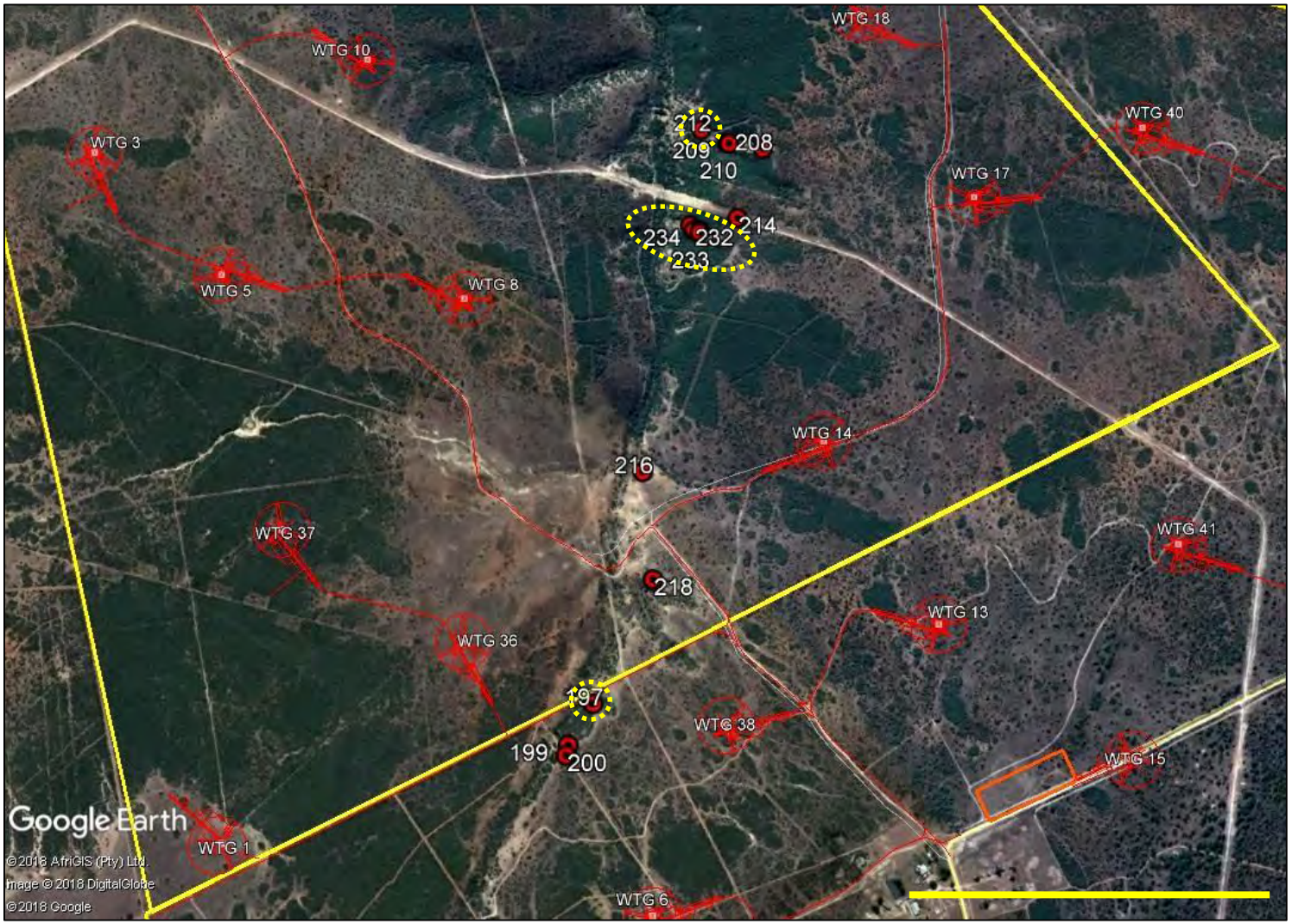

Figure 43. Google Earth© image of the western part of the Bayview Wind Farm project area showing recorded fossil sites (numbered red circles) in relation to the proposed infrastructure such as turbine positions and access roads. Yellow dotted circles and ellipses represent proposed ~50 m-radius buffer zones protecting sensitive fossil sites. Scale bar = 1 km. N towards the top left.

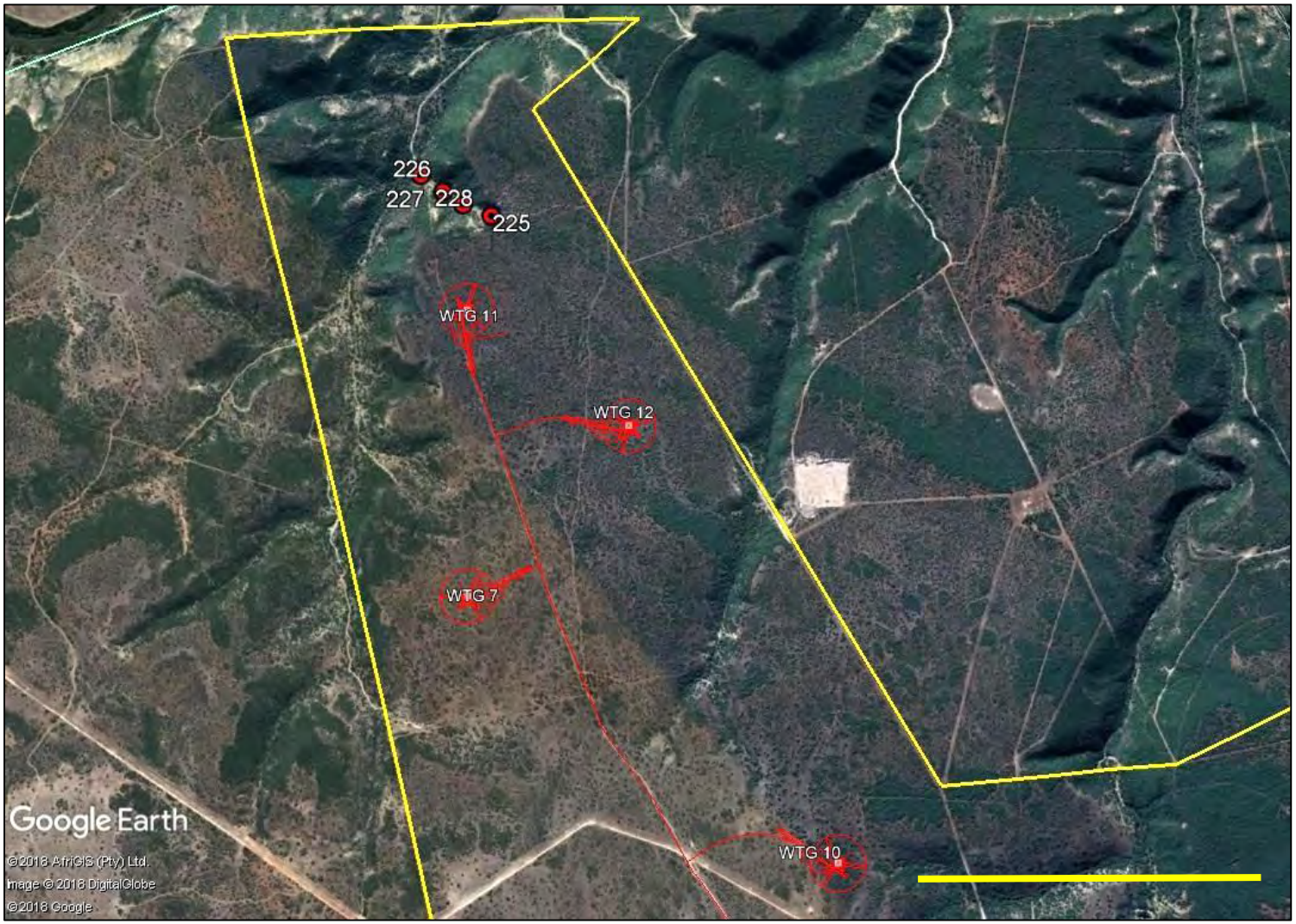

Figure 44. Google Earth© image of the north-western part of the Bayview Wind Farm project area (N part of Ebb & Vloed 230) showing recorded fossil sites (numbered red circles) in relation to the proposed infrastructure such as turbine positions and access roads. Scale bar = 1 km. N towards the top left.

7. Potential impacts on palaeontological heritage and their mitigation

7.1. Cause and comment

The construction phase of the proposed Bayview Wind Farm will entail substantial surface clearance and excavations into the superficial sediment cover and well as into the underlying bedrocks. These notably include excavations for turbine foundations (*c.* 500-1000 m^3 *per* turbine), internal access roads, underground cables, the on-site switching station, electricity pylon footings (small) and associated building infrastructure. In addition, sizeable areas of bedrock may be sealed-in or sterilized by infrastructure such as hard standing areas for wind turbines, laydown areas, as well as the new gravel road system. All these developments may adversely affect scientifically valuable and legally-protected palaeontological heritage preserved at or below the ground surface within the study area by destroying, disturbing or permanently sealing-in fossils which are then no longer available for scientific research or other public good. The operational and de-commissioning phases of the wind farm development are unlikely to involve further adverse impacts on local palaeontological heritage, however.

7.2. Palaeontological sensitivity of WEF project area

The palaeontological sensitivity of the various sedimentary outcrop areas shown on the geological map within the Wind Farm study area (Fig. 7) has been gauged on the basis of desktop studies (Almond 2017), several previous field-based assessments carried out in the region and the recent site visit. In general terms, the palaeosensitivity of the Sundays River Formation that crops out in lower-lying areas (including dry river valleys) and along the margins of the Sundays River Valley is HIGH. Upland areas of the Grassridge Plateau that are mantled by the Alexandria Formation are of LOW to MEDIUM sensitivity, while alluvial terrace sediments of the Kudus Kloof Formation towards the northeast are of LOW sensitivity (*cf* SAHRIS website palaeosensitivity map and legend to Fig. 7).

The majority of the fossil sites recorded during the recent field study lie within the Sundays River Formation outcrop area and are assigned a Proposed Field Rating of IIIC to IIIB Local Resource (Low to Medium Significance) (See tabulated locality, geological and palaeontological data in Appendix 1). The only highly-significant palaeontological sites (Proposed Field Rating of IIIA Local Resource) are Loc. 197 on Olifants Kop 201 as well as Loc. 212 and Locs. 231-234, all on Ebb & Vloed 230. These scientifically important sites are highlighted in Figure 43 by yellow dotted shapes representing a proposed *c*. 50 m-radius protective buffer zone around them. As seen in satellite images in Figures 42 to 44, none of the identified sites should be impacted directly by the proposed wind farm development (Note that low significance fossil site Loc. 184 is situated within an existing borrow pit that will not be exploited as part of the wind farm development). It is significant that the great majority of proposed wind turbine sites are located in flatter-lying upland areas that are mantled by the comparatively unfossiliferous Alexandria Formation and other fossil-poor superficial sediments. This also applies to most of the access road network (red lines in Figs. 42 to 44), the operational and maintenance buildings (pink area in Fig. 43) and the alternative on-site switching station footprints (Fig. 45). Severe negative impacts on buried or exposed fossils during the construction phase of the wind farm are therefore not anticipated.

7.3. Wind farm impact assessment, with and without mitigation

The following palaeontological heritage assessment – summarized in Table 1 - applies to the *construction phase* of the wind farm and takes into consideration all the key infrastructural components of the Bayview Wind Farm outlined in Section 1. These include *inter alia* wind turbines, hard standing areas, access roads, underground cables as well as the combined on-site switching station and associated operational and maintenance buildings (*N.B.* The overhead powerline connection options to the national grid are assessed separately in Section 7.6 below). Further significant impacts on fossil heritage during the operational and de-commissioning phases of the wind farm are not anticipated so these phases are not separately assessed here.

The destruction, damage or disturbance out of context of legally-protected fossils preserved at or below the ground surface that may occur during construction of the wind farm entail *direct negative* impacts to palaeontological heritage resources that are confined to the development footprint and limited parts of the site (*localised* extent). These impacts can often be effectively mitigated (mitigatation *achievable*) but they are *permanent* and cannot be fully rectified (*low reversibility*). All of the sedimentary formations represented within the Bayview Wind Farm study area may contain fossils of some sort (*e.g*. microfossils, trace fossils) so palaeontological impacts at some level are inevitable. However, impacts on *scientifically important, well-preserved, unique or rare fossil material* that is worthy of special protection / conservation, while *possible*, are unlikely. Given the general low palaeontological sensitivity of the study area within the development footprint, the severity of impacts is anticipated to be *slight* (Severe local impacts on highly-significant fossil remains – such as very rare vertebrate fossils like dinosaurs – cannot be completely excluded). Most - but *not* all - of the fossils concerned are likely to be of widespread occurrence within the large outcrop areas of the formations concerned; the probability of loss of *unique or rare* fossil heritage is therefore low (*low resource irreplaceability*).

It is concluded that, without mitigation, the overall impact significance of the proposed wind farm development is *LOW (negative)*. Given the fairly extensive palaeontological field data now available for the broader study area near Coega / Uitenhage, confidence levels for this assessment are rated as *moderate*. Should the recommended mitigation measures for the construction phase of the wind farm – as outlined in Section 7.5 below and the Chance Fossil Finds Procedure (Appendix 2) - be fully implemented, the impact significance of the project is still likely to remain *LOW (negative)*. However, in this case any small residual impacts due to loss of fossil heritage would be partially offset by the *positive* impact represented by an improved palaeontological database for the Grassridge region as a direct result of appropriate mitigation. This is a *positive* outcome because any new, well-documented and suitably curated fossil material from this palaeontologically under-recorded part of the Eastern Cape would constitute a useful addition to the scientific understanding of the fossil heritage here.

When considering the **No-Go Alternative** (*i.e.* no wind farm development), impacts on local fossil heritage would be essentially *neutral to slightly beneficial*. Without development, natural weathering processes and erosion will continue to steadily destroy fossils preserved near or at the ground surface, but at the same time new fossils will be continually exposed. The no-go alternative would forgo potential improvements in the palaeontological understanding of the study region through any well-mitigated new fossil finds made during construction.

7.4. Cumulative impacts

Existing or proposed wind farms in the vicinity of the Bayview Wind Farm project area for which palaeontological heritage assessments are available include projects on Grassridge 190, Geluksdal 590 and Bontrug 301 (Almond 2011), the Dassiesridge WEF (Almond 2014) and the Scarlet Ibis Wind Energy Farm (Gess 2017). Also relevant are palaeontological heritage field surveys for the Coega IDZ (Almond 2010) and several Transnet railway infrastructure projects in the region (Almond 2012, 2013).

The fossil heritage impact significance of the existing Grassridge WEF and the proposed Dassiesridge WEF just to the NW were assessed as low by Almond (2011, 2012). Impacts in the Grassridge WEF area mainly concern poorly-fossiliferous, recrystallized marine limestones of the Alexandria Formation similar to those underlying the main development footprint for the Dassiesridge WEF and Bayview Wind Farm. While pockets of rich shelly fossil assemblages may occasionally be encountered here,(*cf* Gess 2017 for the Scarlet Ibis Wind Farm study area, located only 8 km SW of the Bayview Wind Farm project area), these limestones and their (usually sparse) associated fossils are of widespread occurrence within the broader Port Elizabeth – Uitenhage region (*cf* Almond 2010). Direct impacts on fossiliferous beds of the Sundays River Formation due to wind farm developments are generally much more restricted. *Provided* that the palaeontological mitigation measures proposed for all the individual projects are carried through, the cumulative impacts of the various wind energy facilities in the Grassridge – Coega region, including their associated grid connections, are likely to be *LOW (negative).*

7.5. Recommended monitoring and mitigation

Given the low palaeontological sensitivity of the great majority of the Bayview Wind Farm project area, and the fact that direct impacts on recorded sensitive fossil sites in the area are not anticipated, no specialist palaeontological monitoring or mitigation is recommended here for this project, pending the potential discovery of significant new fossil remains during the construction phase.

The suitably qualified & experienced Environmental Control Officer (ECO) responsible for the construction phase of the wind farm development should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. Several known sensitive fossil sites lying outside the proposed development footprint but within the wind farm project area (those outlined with yellow dotted ellipses in Fig. 43) should be safeguarded from damage or disturbance during the construction phase (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

During the construction phase all major clearance operations and deeper (> 1 m) excavations (*e.g.* for new access roads, turbine placements) should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible. This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the proponent's expense. These

recommendations are summarized in the tabulated Chance Fossil Finds Procedure appended to this report (Appendix 2).

The palaeontologist concerned with any mitigation work will need a valid fossil collection permit from ECPHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by SAHRA (2013).

These monitoring and mitigation recommendations are to be incorporated into the Environmental Management Programme (EMPr) for the Bayview Wind Farm. The operational and decommissioning phases of this development are unlikely to have further significant impacts on palaeontological heritage and no additional recommendations are made in this regard (The Chance Fossil Finds Procedure still applies).

Table 1 (following page). Assessment of potential impacts on local palaeontological heritage resources for the Bayview Wind Farm (construction phase).

Impacts on Paleontological Sites	Construction Phase	All Alternatives	Direct and Cumulative	The construction phase of the proposed Wind Farm development will entail substantial surface clearance and excavations into the superficial sediment cover as well as the underlying bedrocks. These notably include excavations for turbine foundations, internal access roads, underground cables, the on-site substation, pylons and associated building infrastructure. In addition, sizeable areas of bedrock may be sealed-in or sterilized by infrastructure such as hard stand areas for wind turbines, lay down areas, as well as the new gravel road system. All these developments may adversely affect valuable and legally-protected palaeontological heritage preserved at or below the ground surface within the study area by destroying, disturbing or permanently sealing-in fossils which are then no longer available for scientific research or other public good. The operational and decommissioning phases of the wind farm development are unlikely to involve further adverse impacts on local palaeontological heritage.	**LOW -**	Slight	Localised	Permanent	May Occur	Achievable	• Monitoring of all substantial bedrock excavations on an on-going basis by the ECO with reporting of significant Chance Fossil Finds to ECPHRA for professional mitigation (See Appendix 2). • Safeguarding of recorded sensitive fossil sites (outlined in Fig. 43 of palaeontological heritage report) from disturbance or damage during construction phase (Taping- or fencing-off of sites *not* recommended).	**LOW -**
		No-Go Alternative		Under the no-go option the palaeontological heritage would not be disturbed.	**LOW +**	Neutral to slightly beneficial				N/A		**LOW +**

7.6. Assessment of transmission line route options

A new 132 kV or 220 kV overhead powerline with monopole or lattice towers will connect the proposed Bayview Wind Farm on-site switching station - for which two site alternatives (A, B) are under consideration - to the Eskom national grid *via* an existing substation (Grassridge, Brakrivier or Dedisa Substation). The various route options for the overhead powerline are shown in Figure 45 below and superimposed on a geological map in Figure 46. Four grid connection options are currently under consideration:

- A loop-in loop-out (LILO) on the Grassridge / Nooitgedacht 132 kV OHL (blue line in Fig. 45);
- A direct line to the Grassridge Substation (green line in Fig. 45);
- A direct line to Dedisa Substation (red line in Fig. 45);
- A direct line to Dedisa Substation *via* the CDC Corridor (Orange line in Fig. 45).

The chosen route will require a servitude of 30-39 m width while line construction will involve vegetation clearance of a 8 m-wide strip down the centre of the servitude.

One or more of the following properties will be crossed by the new powerline, depending on the route option finally chosen: Oliphants Kop 201 / Remaining Extent , Steins Valley 202 / Portion 4 , Ebb and Vloed 230 / Remaining Extent of Portion 8, Oliphants Kop 201 / Portion 1, Grassridge 225 / Remaining Extent, Remaining Extent of Coega Erf 246, Remaining Extent of Coega Erf 248, Coega Erf 329, Uitenhage Farms 612, Farm 717, Remaining Extent of the Farm Grassridge 227, Farm Grassridge 228, Remaining Extent of the Farm Geluksdal 590.

The geological units underlying the various powerline route options are shown in Figure 46 (See Fig. 7 for key to these units). Several fossil sites from the Sundays River and Alexandria Formations close to (few km) the powerline study area have been documented in previous palaeontological assessment reports for the Coega IDZ (Almond 2010), the Bontrug and Grassridge areas (Almond 2011) and the Tankatara area (Almond 2012, 2013) as well as the present field study (Selected examples are indicated by black stars in Fig. 46). Note that none of the recorded fossil sites lies directly within a powerline servitude under consideration for the Bayview Wind Farm.

For each route option, the greater part will traverse calcretes and surface gravels overlying the Alexandria Formation capping the Grassridge Plateau. Surface exposure of potentially fossiliferous lower Alexandria Formation beds here is generally low, and direct impacts on these beds due to small pylon footings are likely to be minimal. Two short sectors of powerline corridor that traverse outcrop areas of the Sundays River Formation as well as Late Caenozoic alluvium along incised drainage lines are indicated by black rectangles in Figure 46. In the case of the Brakrivier Substation area bedrock exposure is very low (due to dense vegetation, soils) and direct impacts on fossiliferous bedrock are accordingly likely to be low. Several fossil sites (black stars in Fig. 46) are recorded from the Sundays River beds close to the blue-coded powerline route across Ebb and Vloed 230 (*i.e.* loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL) but these sites lie outside the proposed servitude. One scientifically important, conservation-worthy site on Ebb and Vloed 230 (Loc. 197, Proposed Field Rating IIIA Local Resource; see Fig. 43) lies *c*. 40 north of a powerline route option and should not be disturbed during the construction phase.

Given (1) the shortness of the powerline, (2) the small scale excavations required for pylon footings and access roads and (3) the low palaeontological sensitivity of the great majority of the corridor sectors concerned, it is concluded that the impact significance of all four grid connection options under consideration is *LOW (negative).* The direct line to the Grassridge Substation has the lowest impact significance while the loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL has the highest impact significance. However, there is no marked preference for any particular grid connection option on palaeontological heritage grounds.

No specialist palaeontological monitoring or mitigation for the construction phase of the Bayview Wind Farm grid connection is recommended here, *provided that*:

- the proposed Chance Fossil Finds Procedure (Appendix 2) is fully implemented;
- Loc. 197 on Ebb and Vloed 230 (Fig. 43) is safeguarded during the construction phase, if the loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL powerline route is chosen (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

These recommendations should be included within the Environmental Management Programme for the proposed wind farm grid connection.

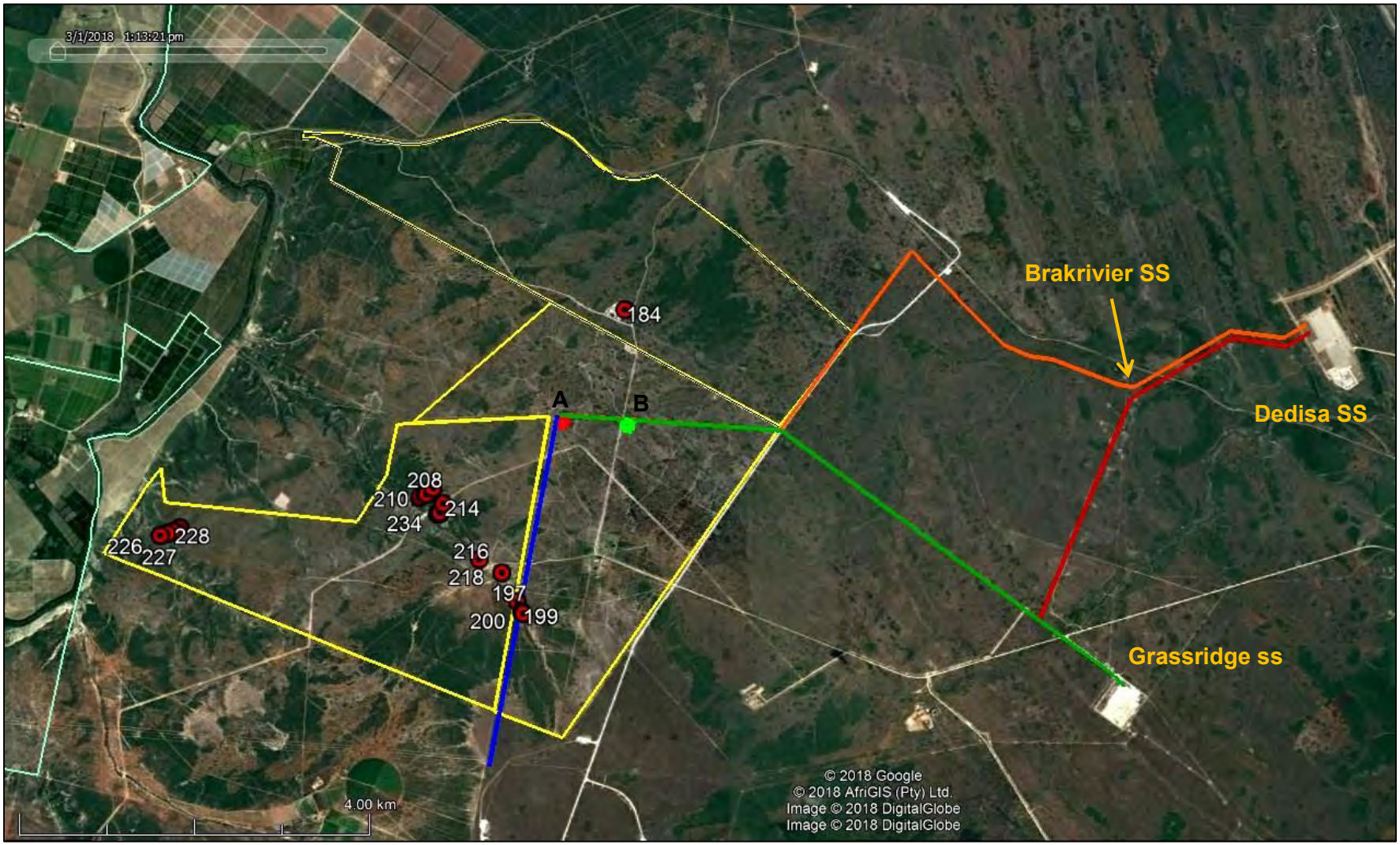

Figure 45. Various 132 kV or 220 kV overhead powerline route options under consideration to connect the Bayview Wind Farm (yellow polygon) with the national grid *via* an existing substation. On-site switching station site options are A (red square) and B (green square). Blue line = loop-in loop-out (LILO) on the Grassridge / Nooitgedacht 132 kV OHL. Green line = direct line to the Grassridge Substation. Red line = direct line to Dedisa Substation. Orange line = direct line to Dedisa Substation *via* the CDC Corridor. *N.B.* North is towards the LHS of the image.

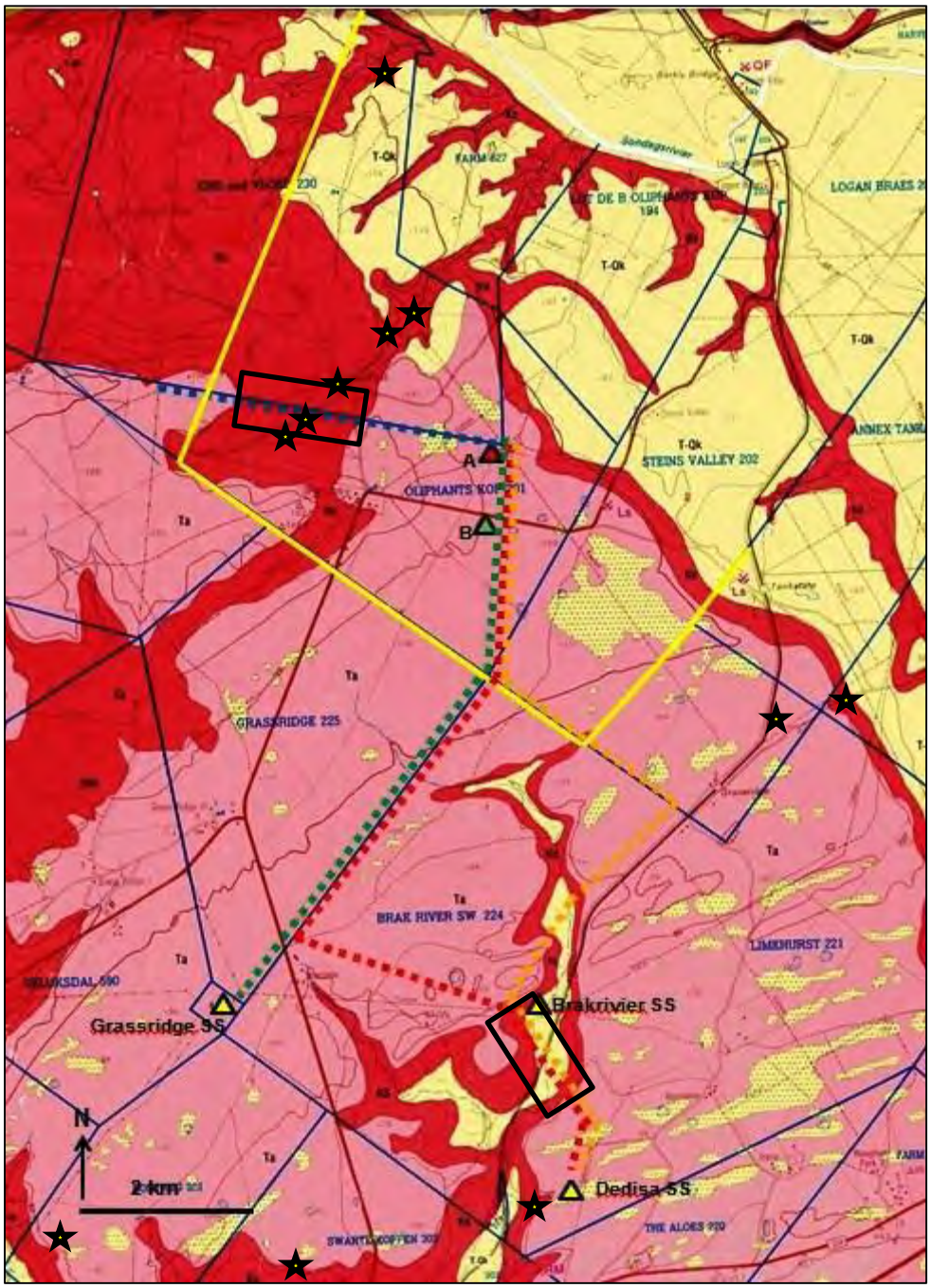

Figure 46. Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing the sedimentary rock units underlying the various grid connection route options under consideration (Compare previous figure). *Selected* fossil sites in the Sundays River and Alexandria Formation from the present study as well as Almond (2010, 2011) are shown by black stars. Short sectors underlain by potentially-fossiliferous marine sediments of the Sundays River Formation are indicated by black rectangles. The sector close to Brackrivier Substation has poor bedrock exposure while several fossiliferous Sundays River Formation exposures are seen on Ebb & Vloed 230 close to (but ≥ 40 m, *i.e.* outside servitude) the blue powerline route (loop-in loop-out (LILO) on the Grassridge / Nooitgedacht 132 kV OHL).

8. Conclusions

The Bayview Wind Farm project area, situated on the Grassridge Plateau some 25 km northeast of Uitenhage, Uitenhage District, Eastern Cape, is largely underlain by Neogene (Late Tertiary) shallow marine deposits of the Alexandria Formation (Algoa Group) as well as Early Cretaceous sandstones and mudrocks of the Sundays River Formation (Uitenhage Group). Younger superficial sediments in the area include Plio-Pleistocene alluvial terrace deposits of the Kudus Kloof Formation bordering the Sundays River Valley as well as downwasted surface gravels of the "Blue Water Bay" facies, relicit patches of Nanaga Formation aeolian sands, calcrete hardpans and various soils. Previous academic and palaeontological impact assessment studies in the broader Grassridge Plateau region suggest that, while rich pockets of shelly fossil remains occur here in both the Sundays River and Alexandria Formations, the area is generally of low palaeontological sensitivity due to poor bedrock exposure, weathering and leaching or calcretisation of near-surface sediments.

Recent field studies in the Bayview project area have recorded (1) several scientifically-important fossil sites (*e.g.* intact marine molluscs, shelly hash, petrified wood, trace fossils) within small exposures of Sundays River beds located along the margins of incised dry valleys, especially on farm Ebb and Vloed 230, as well as (2) very sparse, poorly-preserved shells within the highly calcretised Alexandria Formation on the Grassridge Plateau (*e.g.* Steins Valley 202) (See Appendix 1). None of these sites lies directly within the proposed development footprint. The younger superficial sediments are very sparsely fossiliferous, at most (*e.g.* rare rounded clasts of petrified wood reworked from the Karoo Supergroup found in surface gravels, as well as flaked stone artefacts within Pleistocene Nanaga aeolianites).

It is concluded that, *without* mitigation, the overall impact significance of the proposed wind farm development is *LOW (negative)*. Confidence levels for this assessment are rated as *moderate*. Should the recommended mitigation measures for the construction phase of the wind farm – as outlined in the Chance Fossil Finds Procedure (Appendix 2) - be fully implemented, the impact significance of the wind farm project is still likely to remain *LOW (negative)*. However, in this case any small residual impacts due to loss of fossil heritage would be partially offset by the *positive* impact represented by an improved palaeontological database for the Grassridge region as a direct result of appropriate mitigation. There is no preference on palaeontological heritage grounds for any specific infrastructure layout option under consideration (*e.g.* location of on-site switching station, O&M buildings). For the No-Go Alternative (*i.e.* no wind farm development), impacts on local fossil heritage would be essentially *neutral to slightly beneficial*. Taking into consideration several other existing or proposed wind energy developments in the region which impact similar bedrocks and fossil assemblages, the cumulative impacts of these projects together with the Bayview Wind Farm and their associated grid connections are assessed as low (negative).

There is no objection on palaeontological heritage grounds to authorisation of the proposed Bayview Wind Farm, *provided that* the recommended monitoring and mitigation measures are implemented (Section 7.5). Given the low palaeontological sensitivity of the great majority of the Bayview Wind Farm project area, and the fact that direct impacts on recorded sensitive fossil sites in the area are not anticipated, no specialist palaeontological monitoring or mitigation is recommended here for this

project, pending the potential discovery of significant new fossil remains during the construction phase.

The suitably qualified & experienced Environmental Control Officer (ECO) responsible for the construction phase of the wind farm development should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. Several known sensitive fossil sites lying outside the proposed development footprint but within the wind farm project area (those outlined with yellow dotted ellipses in satellite map Fig. 43 herein) should be safeguarded from damage or disturbance during the construction phase (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

During the construction phase all major clearance operations and deeper (> 1 m) excavations (*e.g.* for new access roads, turbine placements) should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible. This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the proponent's expense. These recommendations are summarized in the tabulated Chance Fossil Finds Procedure appended to this report (Appendix 2).

The palaeontologist concerned with any mitigation work will need a valid fossil collection permit from ECPHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by SAHRA (2013).

These monitoring and mitigation recommendations are to be incorporated into the Environmental Management Programme (EMPr) for the Bayview Wind Farm. The operational and decommissioning phases of this development are unlikely to have further significant impacts on palaeontological heritage and no additional recommendations are made in this regard (The Chance Fossil Finds Procedure still applies).

8.1. Bayview grid connection

Four route options for a new 132 kV or 220 kV overhead powerline connecting the Bayview Wind Farm on-site switching station to the National Grid *via* the existing Grassridge, Brakrivier or Dedisa Substations are under consideration. Given (1) the shortness of the powerline, (2) the small-scale excavations required for pylon footings and access roads and (3) the low palaeontological sensitivity of the great majority of the powerline corridor sectors concerned, it is concluded that the impact significance of all four grid connection options under consideration is *LOW (negative).* The direct line to the Grassridge Substation has the lowest impact significance while the loop-in loop-out on the

Grassridge / Nooitgedacht 132 kV OHL has the highest impact significance. However, there is no marked preference for any particular grid connection option on palaeontological heritage grounds.

No specialist palaeontological monitoring or mitigation for the construction phase of the Bayview Wind Farm grid connection is recommended here, *provided that*:

- the proposed Chance Fossil Finds Procedure (Appendix 2) is fully implemented;
- Loc. 197 on Ebb and Vloed 230 (Fig. 43) is safeguarded during the construction phase, if the loop-in loop-out on the Grassridge / Nooitgedacht 132 kV OHL powerline route is chosen (*N.B.* Taping- or fencing-off of the site is *not* recommended since this brings attention to the fossils without really protecting them).

These recommendations should be included within the Environmental Management Programme for the proposed wind farm grid connection.

9. Acknowledgements

Mrs Kim Brent, EOH Coastal & Environmental Services, Port Elizabeth, is thanked for commissioning this study and for providing the necessary background information. I am grateful to local landowners for facilitating access to their property.

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11. Qualifications & experience of the 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 in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. 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 palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Mpumalanga, Free State, Northwest, Limpopo and KwaZulu-Natal under the aegis of his Cape Town-based company *Natura Viva* cc. He has previously served as a long-standing 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).

12. 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 project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

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

APPENDIX 1: GPS DATA 7 FIELD NOTES FOR NUMBERED GEOLOGICAL & PALAEONTOLOGICAL LOCALITIES

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.
N.B. Given the sensitivity and conservation importance of fossil sites in the RSA, this data is *not* for public release.

Loc.	GPS data	Comments
184	S33° 40' 12.6" E25° 40' 57.6"	Steins Valley 202. Extensive shallow quarry excavated into Alexandria Fm massive pebbly to cobbly, clast- to matrix-supported conglomerates (clasts mainly brownish, well-sorted and –rounded quartzites, sandstones with occasional greenish-grey Sundays River sandstones), calcareous sandstones, calcretes. Occasional quartzite boulders with impact crescents. Gently S- and W-dipping banks of calcareous sands and pebbly beds exposed in cut face. Alexandria beds incised by several solution hollows or pipes (< 1m deep) infilled with darker, brownish "Blue Water Bay" downwasted pebbly facies overlain by pinkish later calcrete (*c*. 1m) and dark soils. Sparse, poorly-preserved thick-shelled oysters occur within Alexandria Fm. Proposed field rating IIIC Local Resource.
185	S33° 40' 06.8" E25° 40' 54.5"	Steins Valley 202. Steep cut face through Alexandria Fm crudely-bedded calcretised calcarenites and pebbly beds (*c*. 2m) on NW edge of quarry. Overlies (gradational contact) pale greyish-brown silty saprolite of Sundays River Fm. Darker brown "Blue Water Bay" pebbly facies on top.
186	S33° 40' 20.5" E25° 41' 17.0"	Steins Valley 202. South-eastern project area, roadsides with poorly-sorted, rubbly downwasted calcrete blocks, "Blue Water Bay" pebbly to cobbly conglomerates including sporadic dark grey clasts of Sundays River Fm sandstone. Some quartzite cobbles with reddish-brown patina. Alexandria Fm bedrocks and calcrete hardpan at depth (exposed in track). Brownish domical termitaria.
187	S33° 40' 21.0" E25° 41' 20.6"	Steins Valley 202. Steeper-sloping ground underlain by Sundays River Fm with dense shrubby vegetation. No bedrock exposure.
188	S33° 39' 55.0" E25° 40' 59.6"	Steins Valley 202. Small roadside borrow pit into orange-brown calcareous sediment (Sundays River Fm at depth). Surface pebbly rubble and calcrete possibly downwasted from upslope.
189	S33° 39' 34.9" E25° 41' 18.1"	Steins Valley 202. Kudus Kloof outcrop area with undulating terrain mantled with pebbly to bouldery surface gravels, pale brown soils. Area here infested with *Opuntia* (prickly pear).
190	S33° 39' 42.2" E25° 41' 34.6"	Steins Valley 202. Round open grassy area (perhaps marking doline / solution hollow, pan) with dark grey-brown soils and no gravels except towards margin with raised calcrete rim.
191	S33° 39' 24.4" E25° 41' 29.2"	Steins Valley 202. Kudus Kloof Fm outcrop area – open area with brown alluvial soils, no gravels (*i.e.* younger terrace), domical termitaria.
192	S33° 39' 04.3" E25° 41' 53.2"	Steins Valley 202. Thick, grey-green alluvial silty soils with thin lenses of quartzitic gravels, thin veneer of downwasted surface gravels, overlying Sundays River Fm at depth (probably silty, saprolitic here). Rubified gravel clasts possibly of Enon Formation provenance (or from older Kudus Kloof Fm terrace gravels).
193	S33° 38' 27.8" E25° 42' 13.2"	Steins Valley 202. Roadside borrow pit near Logan Braes overlying Sundays River Fm outcrop area. Pit excavated into thick orange-brown hued, semi-consolidated, well-sorted sands – possibly relict patch of rubified Nanga Formation aeolianites. Occasional quartzite cobbles, angular clasts, some of which may be flaked stone artefacts (*i.e.* possible manuports into ancient Pleistocene sand dunes)
194	S33° 40' 43.5" E25° 40' 19.5"	Olifants Kop 201. Ovoid doline (solution hollow) in Alexandria Fm outcrop area – grassy, disturbed by game aniumals. Shallow surface depression with dark brown surface soils. Sparse surface calcrete rubble and "Blue Water Bay" facies gravels mantle Grassridge Plateau region.
195	S33° 40' 01.2" E25° 39' 49.3"	Olifants Kop 201. Grassridge Plateau area mantled with rubbly surface calcrete, patches of "Blue Water Bay" downwasted gravels and brownish soils.
196	S33° 39' 33.6" E25° 39' 13.5"	Border of Olifants Kop 201 & Eb and Vloed 230. Viewpoint down into shallow dry palaeovalley on Eb and Vloed 230, existing powerline and wind turbines on Grassrige Plateau to west. Poorly-sorted pebbly to cobbly "Blue Water Bay" surface gravels and brownish soils on high ground here.

197	S33° 39' 30.8" E25° 38' 49.9"	Olifants Kop 201 (N margins). Escarpment edge exposures of Sundays River Fm dark greenish-brown weathering, well-indurated, gritty to pebbly, calcareous sandstones, conglomerates underlying Alexandria Fm calcretised calcarenite bench. Zone of reworked subrounded, boulder-sized, dark brown-patinated blocks of Sundays River sandstones form breccio-conglomerate at base of Alexandria Fm succession. Fresh surfaces of well-indurated, fine Sundays River Fm gravels / microbreccias show clast-supported oligomict grits with pinkish and grey, occasional ferruginised or kaolinitised clasts, grains angular to subrounded. Locally abundant highly-comminuted shells (esp. small bivalves), shelly coquinas and slurries, and small wood fragments up to several cm long and across (some retaining fibrous texture which can be teased apart, *i.e.* not permineralised) or wood hash, possible black charcoal fragments within gritty Sundays River beds and reworked blocks. Proposed field rating IIIA Local Resource.
198	S33° 39' 32.2" E25° 38' 44.1"	Olifants Kop 201. Borrow pit near dam. Calcretsied Alexandria Formation overlying possible *in situ* Sundays River Fm saprolite (weathered bedrock).
199	S33° 39' 32.3" E25° 38' 45.3"	Olifants Kop 201. Hillslope and erosion gulley exposure of grey-green Sundays River silty saprolite. Calcretized marine invertebrate burrow casts weathering out of Sundays River beds. Float blocks of well-cemented shelly calcareous Sundays River sandstones / grits. Proposed field rating IIIC Local Resource.
200	S33° 39' 32.9" E25° 38' 44.5"	Olifants Kop 201. Possible root traces within surface calcretes (or recent rootlet marks) exposed in farm track. Age uncertain. Proposed field rating IIIC Local Resource.
201	S33° 39' 32.6" E25° 38' 16.6"	Olifants Kop 201. Roadside erosion gulley exposing weathered, grey-green mudrock Sundays River Fm saprolite with calcrete veining.
202	S33° 40' 04.0" E25° 40' 47.9"	Olifants Kop 201. Shallow doline overlying Alexandria Fm outcrop area. Dark soils with downwasted brown-patinated, well-rounded quartzitic pebbles / cobbles.
204	S33° 40' 00.3" E25° 39' 50.5"	Ebb and Vloed 230. Rubbly downwasted surface calcrete and brownish soils of Grassridge Plateau.
205	S33° 39' 22.7" E25° 39' 52.4"	Ebb and Vloed 230. Areas with concentrations of downwasted pebbly to bouldery, well-rounded, quartzitic gravels (mapped as “Blue Water Bay” facies). Grassy areas without gravels possibly underlain by sandier Kudus Kloof Fm of Nanaga Fm aeolianites.
207	S33° 39' 05.7" E25° 39' 40.2"	Ebb and Vloed 230. Cobbly to bouldery surface gravels (well-rounded grey and brown quartzite) extending along margins of shallow valley. Some clasts rubified; larger examples with impact crescents. Mapped as Kudus Kloof Fm terrace gravels but with possible component of downwasted “Blue Water Bay” facies.
208	S33° 39' 00.5" E25° 39' 40.6"	Ebb and Vloed 230. SE-NW trending erosion gulley intersecting weathered Sundays River Fm bedrocks (grey-green to orange / reddish mottled mudrocks and subordinate sandstones, often crumbly, with darker brown lenses of carbonate-cemented concretionary material) capped by calcretised Alexandria Fm and “Blue Water Bay” surface gravels (in part infilling solution hollows). Calcretized cylindrical marine invertebrate burrow casts (alternatively, superimposed calcretised root casts or rhizoliths) weathering out of Ks. Shelly fossil debris within weathered-out Sundays River sandstone concretions. Proposed field rating IIIB Local Resource.
209	S33° 38' 58.1" E25° 39' 38.1"	Ebb and Vloed 230. SE-NW trending erosion gulley intersecting weathered Sundays River Fm bedrocks. Dark brown calcareous concretions with abundant fossil shells (mainly small bivalves) weathering out of Sundays River succession. Proposed field rating IIIB Local Resource.
210	S33° 38' 57.6" E25° 39' 37.6"	Ebb and Vloed 230. Prominent-weathering bench (*c*. 30 cm) of tough, dense, greyish shelly calcareous sandstone within the Sundays River Fm. Contains numerous well-preserved intact and fragmentary fossils of bivalves. Proposed field rating IIIB Local Resource.
211	S33° 38' 56.3" E25° 39' 37.0"	Ebb and Vloed 230. Pebbly gravels overlying Sundays River Fm saprolite along margins of erosion gulley – probably Kudus Kloof Fm terrace gravels as well as “Blue Water Bay” facies infilling solution hollows in Alexandria Fm calcarenites.
212	S33° 38' 55.4" E25° 39' 36.7"	Ebb and Vloed 230. Prominent-weathering bench of Sundays River Fm greenish-brown weathering calcareous sandstone with abundant shelly fossils (mainly bivalves *plus* small high-spired gastropods, *possible* small terebratulid brachiopods), shell hash, isolated bacculitid straight-shelled ammonite (*cf Bochianites glaber* in Cooper 1981). Proposed field rating IIIA Local Resource.
213	S33° 38' 44.8" E25° 39' 40.4"	Ebb and Vloed 230. Small exposures of pale brown, massive, fine-grained silty to sandy alluvium along banks of shallow valley. Dispersed pebbly clasts and lenses of fine gravels.
214	S33° 39' 04.2" E25° 39' 33.7"	Ebb and Vloed 230. Isolated, well-rounded pebble of petrified / silicified wood showing seasonal growth lines among surface pebbles (probably reworked into “Blue Water Bay” or Kudus Kloof Formation from Beaufort Group *via* Sundays River rather than from Kirkwood Fm).

215	S33° 39' 17.6" E25° 39' 07.7"	Ebb and Vloed 230, close to farmstead. Low-elevation (*c*. 100 m amsl) platy calcretes possibly associated with relict Pleistocene Nanaga Fm aeolianites along margins of valley rather than higher-elevation calcretes (*c*. 120 m amsl) related to Alexandria Fm capping the Grassridge Plateau. Calcretes contain sparse well-rounded quartzite pebbles, probably downwasted from Kudus Kloof Fm or "Blue Water Bay" facies upslope. Locally overlie pale grey-green silty saprolite of Sundays River Fm.
216	S33° 39' 17.2" E25° 39' 08.8"	Ebb and Vloed 230. Erosion gulley exposure of weathered Sundays River Fm with float blocks of dark brown shelly sandstone. Proposed field rating IIIB Local Resource.
217	S33° 39' 23.8" E25° 39' 01.8"	Ebb and Vloed 230. Prominent-weathering bank of gravelly grey facies (stratigraphic assignment unclear).
218	S33° 39' 25.4" E25° 39' 02.7"	Ebb and Vloed 230, W-facing banks of gulley *c*. 240 m SSE of homestead. Thick package of partially-calcretised, relict, orange-hued alluvial or Nanaga Fm sands containing sparse, fresh-looking, weathered-out stone artefacts (Possibly aeolian sands reworked by river action). Lenses or lags of reworked greenish-brown Sundays River concretions, quartzite gravels towards base. Trigoniid steinkern in float (Proposed field rating IIIC Local Resource). Younger calcretes (possibly Pleistocene) capping succession; material may be in part be derived from downwasted calcrete from higher-elevation Grassridge Plateau. Fresh-looking quartzite stone artefacts flaked from cobbles weathering out of aeolianites / alluvium favour Pleistocene age for aeolianites and capping calcrete.
219	S33° 39' 26.7" E25° 39' 03.5"	Ebb and Vloed 230, c. 350 m SSE of homestead. Several meter-thick package of orange-brown aeolian or alluvial sands with creamy calcrete veins, blobs and lenses capped by "younger (Pleistocene) calcretes".
220	S33° 39' 30.0" E25° 39' 04.9"	Ebb and Vloed 230. Small gulley exposure of weathered, greenish, thin-bedded Sundays River Fm saprolite.
221	S33° 39' 11.4" E25° 38' 55.4"	Ebb and Vloed 230. Extensive solid calcrete hardpan due NW from farmstead with views of high-lying older calcretes (Tertiary) and low-lying (Pleistocene / Quaternary) calcretes along slopes of valley to the SE.
222	S33° 37' 34.2" E25° 39' 34.2"	Ebb & Vloed 230. Extensive blanket of pebbly to cobbly (occasionally boulder) quartzitic terrace gravels of Kudus Kloof Fm exposed in farm tracks as well as in adjacent *veld* (often obscured by dense thicket vegetation).
223	S33° 37' 27.5" E25° 39' 27.9"	Ebb & Vloed 230. Good sedimentary rock exposures in steep banks of gulley (with farm track) cutting down to Sundays River from Grassridge Plateau.
224	S33° 37' 26.1" E25° 39' 27.3"	Ebb & Vloed 230. Stratigraphic section through escarpment edge above farm track. (1) Pale grey-green, crumbly, weathered siltstones and subordinate thin, prominent-weathering sandstones of Sundays River Fm sharply overlain by (2) Well-consolidated conglomerates (coarser at top, clasts of well-rounded quartzitic cobbles and pebbles, reworked blocks of Sundays River Fm sandstone) – probably Kudus Kloof Fm and (3) orange-hued alluvial sands and gravels (possibly in part river-reworked Nanaga aeolianites) with capping of (4) Pleistocene calcretes.
225	S33° 37' 26.4" E25° 39' 25.8"	Ebb & Vloed 230. Prominent-weathering bed (*c*. 1.5 m) of well-consolidated pebbly to cobbly, calcrete-cemented conglomerate, matrix- (calcareous sandy to clast-supported, with sharp base incising friable weathered Sundays River Fm mudrocks. *N.B.* This is probably an old (Pliocene) Kudus Kloof Fm alluvial terrace unit at lower elevation (*c*. 80-90 m) than true Alexandria Fm (Miocene – Pliocene) whose conglomeratic base lies at *c*. 120 m amsl in this region of the Grassberg Plateau. No shells (*e.g.* oysters) seen. Breccio-conglomeratic unit locally contains large imbricated collapse blocks of Sundays River sandstone. Sandy calcretised lenses within base of conglomerate bench show bioturbation fabrics – dense assemblages of calcretised cylindrical burrows – and reworked blocks of Sundays River sediments as well as quartzite pebbles. Lower down slope are several prominent-weathering ledges of Sundays River Fm dark greenish-brown sandstone with bioturbation fabric. Also downwasted blocks of Sundays River concretionary sandstone facies with comminuted shelly debris. Proposed field rating IIIC Local Resource.
226	S33° 37' 19.0" E25° 39' 22.3"	Ebb & Vloed 230. Large conical bivalve *Pinna* from Sundays River Fm in surface float towards bottom of *kloof*. Proposed field rating IIIC Local Resource.
227	S33° 37' 21.6" E25° 39' 23.2"	Ebb & Vloed 230. Local concentration of weathered-out trigoniid bivalves (*Steinmanella*) in surface float from Sundays River Fm. Proposed field rating IIIC Local Resource.
228	S33° 37' 23.8" E25° 39' 24.1"	Ebb & Vloed 230. Local concentration of weathered-out trigoniid bivalves (*Steinmanella*) in float. Float block of trigoniid-rich sandstone (*Megatrigonia*) and other bivalves, including oysters. Proposed field rating IIIB Local Resource.

229	S33° 37' 58.0" E25° 39' 30.5"	Ebb & Vloed 230. Road cuttings through calcretised cobbly conglomerates overlying weathered Sundays River Fm at low elevation (*c*. 100 m amsl) – probably Kudus Kloof Fm. Like Alexandria Fm calcretes, bench is penetrated by solution hollows infilled with decalcified, collapse flow-orientated pebbly conglomerates, overlain by dark soils and calcrete rubble. No shells (*e.g.* oysters) seen but laminated calcrete infill can appear shell-like locally.
231	S33° 39' 01.9" E25° 39' 29.2"	Ebb & Vloed 230. SE-NW striking stream gulley at edge of shallow valley with good exposures of Sundays River Fm. Prominent-weathering bench of greenish-brown to ochreous, honeycomb-weathered calcareous sandstone with intensely bioturbated fabric in upper portion, fossil shell moulds and original shell, including trigoniids and oysters. Hardground bedding planes on upper surface of sandstone packages with abundant winnowed-out, often disarticulated thick-shelled trigoniids, *Pinna*. Trigoniid moulds in grey-green mudrocks (prob. *Steinmanella*). Proposed field rating IIIA Local Resource – to be protected by 50 m-radius buffer zone.
232	S33° 39' 02.5" E25° 39' 29.2"	Ebb & Vloed 230. Good stratigraphic section through Sundays River Fm with several prominent-weathering, tabular, greenish-brown sandstones associated with shelly fossils, lenses of shell coquina (variously moulds in sandstone, original shell). *In situ* trigoniids in life orientation with epizoan oysters as well as weathered-out trigoniids in float (*Steinmanella*). Recessive-weathering, grey-green siltstone packages between sandstones. Proposed field rating IIIA Local Resource – to be protected by 50 m-radius buffer zone.
233	S33° 39' 03.0" E25° 39' 29.5"	Ebb & Vloed 230. Weathered-out trigoniids in float (*Steinmanella*), many articulated with original thick, strongly-ornamented shell, weathered-out and downwasted from higher-lying sandstones. Proposed field rating IIIA Local Resource – to be protected by 50 m-radius buffer zone.
234	S33° 39' 02.9" E25° 39' 29.7"	Ebb & Vloed 230. Sandstone source bed (*c.* 20 cm thick) of rich trigoniid assemblages. Dense concentration of (mainly) articulated and inarticulated triginiids (*Steinmanella*) *in situ* but with various orientations – *i.e.* probably transported locally (debris flow). Occasional juveniles as well as adults present. Adult shells sparely encrusted by serpulid worms and thin-shelled oysters. Local concentrations of disarticulated shells form coquinas. Shelly lens persists laterally for at least 3 m. Proposed field rating IIIA Local Resource – to be protected by 50 m-radius buffer zone.
235	S33° 39' 03.0" E25° 39' 30.1"	Ebb & Vloed 230. Sundays River Fm capped along gulley margins by weathered, low-elevation calcretes (*c*. 95 m amsl) of probable Pleistocene age, pebbly gravels and pale gravelly soils.
236	S33° 39' 04.4" E25° 39' 31.2"	Ebb & Vloed 230. Calcretised pebbly conglomerate at head of kloof – probably Kudus Kloof Fm alluvial gravels.

APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Bayview Wind Farm near Uitenhage		
Province & region:	EASTERN CAPE, Uitenhage District	
Responsible Heritage Resources Authority	ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za)	
Rock unit(s)	Sundays River Formation (Uitenhage Group), Alexandria and Nanaga Formations (Algoa Group), Kudus Kloof Formation	
Potential fossils	Shelly marine fossils, reworked wood, trace fossils and very rare vertebrate remains in the Sundays River Fm. Shelly marine fossils in the Alexandria Formation. Possible reworked mammalian remains (bones, teeth, horn cores), freshwater molluscs in Late Caenozoic alluvium (*e.g.* Kudus Kloof Fm), reworked petrified wood in surface and alluvial gravels.	
ECO protocol	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.	
	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)	
	3. If feasible to leave fossils *in situ*: • Alert Heritage Resources Authority 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 Authority for work to resume	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 Authority and project palaeontologist (if any) who will advise on any necessary mitigation
	4. If required by Heritage Resources Authority, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.	
	5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority	
Specialist palaeontologist	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 Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.	