PROPOSED 132 KV TRANSMISSION INTEGRATION PROJECT FOR THE MARALLA WEST & MARALLA EAST WIND ENERGY FACILITIES NEAR SUTHERLAND, SUTHERLAND MAGISTERIAL DISTRICT, NORTHERN CAPE: PALAEONTOLOGICAL HERITAGE BASIC ASSESSMENT

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EXECUTIVE SUMMARY

It is planned to connect the BioTherm Energy's authorised Maralla West and Maralla East Wind Energy Facilities (WEFs), situated in the Klein-Roggeveldberge region of the Great Karoo some 30-40 km to the south of Sutherland, Northern Cape, to the national electricity grid. The currently approved powerline would feed into the existing Eskom Komsberg Main Transmission Substation, situated *c*. 25 km to the southwest of the Maralla WEF project areas on Farm Standvastigheid 210, Northern Cape Province. A new 132 kV grid connection to the Karusa WEF substation on De Hoop 202 has now been proposed, with three route options under consideration.

Middle Permian sedimentary bedrocks of the Abrahamskraal Formation (Lower Beaufort Group) in the Klein-Roggeveldberge powerline study region have yielded scientifically-important fossils of petrified wood and other vascular plants, tetrapod (terrestrial vertebrate) and lungfish burrows and trackways *plus* exceedingly rare skeletal remains of the *Tapinocephalus* Assemblage Zone, but well-preserved fossils are very sparsely distributed. The Abrahamskraal Formation bedrocks here are extensively covered by Late Caenozoic superficial sediments (*e.g.* scree, surface gravels, alluvium, gravelly soils) that are usually unfossiliferous. The overall palaeontological sensitivity of the study area is rated as low, although the potential for rare fossil sites of high palaeontological interest cannot be entirely discounted.

Most of the study area for the present WEF electrical infrastructure project has already been palaeontologically surveyed, *viz.* the Maralla West WEF, Maralla East WEF, Soetwater WEF and Karusa WEF project areas. The remainder has been covered by a supplementary 3-day site visit in October 2021.The great majority of the fossils recorded so far within the Maralla grid connection project area comprise widely-occurring forms (poorly-preserved fossil wood, sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of exceptional scientific or conservation value. None of the fossil sites recorded here lies within the footprints of the 132 kV powerline route options under consideration (see satellite map Appendix 1, Figures A1.1 & A1.2). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

The impact significance of the construction phase of the 132 kV powerline for the Maralla West and Maralla East WEFs is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources. This is a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the project area as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to all three powerline corridors to Karusa Substation under consideration here. All the new powerline options to the Karusa Substation are likely to have a

lower impact significance than the considerably longer approved connection to the Komsberg Substation. Impacts due to the construction of new access powerline access roads will probably be greater than those attributable to excavations for pylon footings. Significant further impacts during the operational and de-commissioning phases of the electrical infrastructure are not anticipated. There are therefore no preferences on palaeontological heritage grounds for any particular powerline route option among those under consideration. The no-go alternative (*i.e.* no development) will probably have a low (neutral) impact on palaeontological heritage.

Cumulative impacts on palaeontological heritage resources that are anticipated as a result of the numerous renewable energy developments currently proposed or authorised for the Klein-Roggeveldberge region, including the Maralla West and Maralla East WEFs and their electrical infrastructure, are anticipated to be MODERATE (NEGATIVE). Their significance would probably fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*cf* Almond 2016f). These anticipated levels of change are *acceptable*.

There are no fatal flaws in the Maralla WEF grid connection infrastructure development proposal as far as fossil heritage is concerned. *Provided that* the recommendations for palaeontological monitoring and mitigation outlined below (See also Section 6 of this report) are fully implemented, there are no objections on palaeontological heritage grounds to authorisation of the proposed 132 kV powerline. Pending the potential discovery of significant new fossil remains during construction, specialist palaeontological mitigation is not recommended for this project. The following general recommendations concerning conservation and management of palaeontological heritage resources apply (See tabulated Chance Fossil Finds Protocol in Appendix 2).

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The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Maralla WEF grid connection development should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads, pylon footings) and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO / ESO. Should significant fossil remains - such as vertebrate bones and teeth, or petrified logs of fossil wood - be encountered at surface or exposed during construction, the ECO / ESO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management agency as soon as possible - *i.e.* SAHRA (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). 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 developer's expense.

These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Maralla WEF powerline project. Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency (in this case SAHRA for the N. Cape and Heritage Western Cape for the W. Cape);

- The palaeontologist concerned with potential mitigation work will need a valid fossil collection permit from Heritage Western Cape (W. Cape) / SAHRA (N. Cape) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection);

- All palaeontological specialist work should 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 HWC (2021) and SAHRA (2013).

1. INTRODUCTION

1.1. Scope of Work

The brief for the present Basic Assessment PIA (palaeontological impact assessment) report is to provide an authoritative, reasoned assessment of potential impacts on palaeontological heritage resources posed by the construction of 132 kV powerline connection between the authorized Maralla West and Maralla East Wind Energy Facilities (WEFs) situated in the Klein-Roggeveldberge region of the Great Karoo near Sutherland, Northern Cape, and the national grid *via* the new Karusa WEF substation on Farm De Hoop 202. Three powerline route options, ranging approximately 17.5 to 19 km in length, are currently under consideration. These are referred to as Option 1A, 1B and 2A and indicated in blue, white and yellow respectively in Figure 1. The currently approved, and considerably longer (*c*. 28 km), grid connection (DEA Ref: 14/12/16/3/3/1/1774) from the Maralla substation on Drie Roode Heuwels 180 feeds into the existing Komsberg Main Transmission Substation on Farm Standvastigheid 210 near Sutherland, Northern Cape Province (green line in Figure 1).

The present assessment is largely based on palaeontological data from a recent, three-day site visit to the new grid connection project area combined with a desktop review of previous palaeontological field surveys for the Komsberg Substation (Almond 2015b), Karusa WEF (Almond 2015c), Soetwater WEF (Almond 2015d), Maralla West WEF (Almond (2016h) and Maralla East WEF (Almond 2016i). A desktop palaeontological heritage assessment of the currently authorised grid connect to the Komsberg MTS was submitted by Almond (2017). Recommendations for any necessary palaeontological mitigation or management measures before or during the construction phase of the powerline are also made.

1.2. Objectives of the report

The present PIA report assesses potential impacts on local palaeontological heritage resources due to the construction of a 132 kV grid connection between the authorised Maralla WEF substation on Drie Roodeheuwels 180 to the new Karusa WEF substation on De Hoop 202. The three grid connection route options currently under consideration traverse the projects areas for the Maralla West, Soetwater and Karusa WEFs (Fig. 1).

The new Maralla East WEF and Maralla West WEF grid connection project area is located in a region that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age (See Section 3 of this report). The construction phase of the proposed powerline and associated access roads will entail extensive surface clearance as well as excavations into the superficial sediment cover and underlying bedrock. The development may adversely affect legally-protected fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The planning, operational and de-commissioning phases of the powerline are unlikely to involve further adverse impacts on local palaeontological heritage.

Combined desktop and field-based palaeontological heritage assessments (PIAs) of the Maralla West WEF and Maralla East WEF project areas (Almond 2016h, 2016i) were submitted as part of the EIA

Phase for the WEF developments that are being co-ordinated on behalf of BioTherm Energy (Pty) Ltd (BioTherm) by WSP | Parsons Brinckerhoff, Environment & Energy, Africa (Contact details: Ms Ashlea Strong. WSP | Parsons Brinckerhoff, Environment & Energy, Africa. WSP House, Bryanston Place, 199 Bryanston Drive, Bryanston, 2191, South Africa. Tel: +27 11 361 1392. Mob: +27 82 786 7819. Fax: +27 11 361 1381. E-mail: Ashlea.Strong@WSPGroup.co.za). Comparable palaeontological assessments for the adjoining Karusa WEF, Soetwater WEF, Komsberg East WEF and the expanded Eskom Komsberg Substation have also been submitted by the author (See References). A desktop assessment of the original Maralla grid connection to the Komsberg MTS was submitted by Almond (2017).

1.3. Legislative Framework

The present palaeontological heritage assessment report contributes to the comprehensive heritage Basic Assessment for the proposed 132 kV powerline and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme (EMP) for this electrical infrastructure 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; and
- 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 Heritage Western Cape, HWC (2021) and the South African Heritage Resources Agency, SAHRA (2013).

1.4. Study approach and methodology

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 field assessment 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 Western, Eastern and Northern Cape have already been compiled; *e.g.* Almond & Pether 2008a, 2008b and SAHRIS website). The likely impacts of the proposed development on local fossil heritage are 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 significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field-based assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation or monitoring required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment 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 planning, operational or de-commissioning phases. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) 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 authorities, *i.e.* SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff. Heritage Officer Archaeology, Palaeontology & Meteorites Unit, SAHRA. 111 Harrington Street, Cape Town, 8001. Tel: +27 (0)21 202 8651. Fax: +27 (0)21 202 4509 E-mail:rredelstorff@sahra.org.za) and

Heritage Western Cape for the Western Cape (Contact details: Heritage Western Cape. Protea Assurance Building, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 086-142 142. Fax: 021-483 9842. Email: hwc@pgwc.gov.za). It should be emphasized 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.

In summary, the approach to a Phase 1 palaeontological heritage study is as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and relevant geological sheet explanations as well as satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous palaeontological assessments of the broader study region, and the author's field experience and palaeontological database. Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed in this case using the methodology selected by WSP | Parsons Brinckerhoff, Environment & Energy, Africa. Recommendations for any further palaeontological studies or mitigation considered necessary are specified.

The present desktop PIA study was undertaken in line with the HWC (2021) and SAHRA (2013) Minimum Standards for the palaeontological component of heritage impact assessment. It was largely based on the following sources of information:

1. A brief project outline, maps and kmz files provided by WSP | Parsons Brinckerhoff, Environment & Energy, Africa;
2. Relevant 1: 50 000 and 1: 250 000 scale topographic maps (3220DC Swartland, 3220DA Verlatekloof, 3220 Sutherland) as well as corresponding 1: 250 000 scale geological maps and sheet explanations (*e.g.* Theron 1983, Theron *et al.* 1991, Cole & Vorster 1999) as well as Google Earth© satellite imagery;
3. Several palaeontological heritage assessment reports by the present author for proposed developments in the Klein-Roggeveldberge region between Sutherland and Matjiesfontein. They include palaeontological assessments for the the Komsberg Substation (Almond 2015b), Karusa WEF (Almond 2015c), Soetwater WEF (Almond 2015d), Komsberg West WEF (Almond 2015f) as well as the Maralla West WEF (Almond 2016h), Maralla East WEF (Almond 2016i) and Maralla grid connection (Almond 2017).
4. Additional palaeontological fieldwork focussing on areas of potential palaeontological sensitivity (as identified from satellite imagery) within the broader Maralla WEF grid connection project area, carried out by the author and an experienced assistant (27-29 September 2021). The season during which the site visits were conducted has little influence on the outcome, provided that weather conditions for palaeontological fieldwork are good, as was the case here.
5. The author's previous experience with the formations concerned and their palaeontological heritage (*cf* Almond & Pether 2008a-b and references listed above).

Fossil localities that were recorded during previous field-based palaeontological surveys in the vicinity of the broader grid connection project area during recent and previous fieldwork are shown in relation to the powerline corridors under consideration on the satellite images provided in Figures A1.1 and A1.2 in Appendix 1 (*N.B.* No palaeontological survey has been conducted for the Great Karoo WEF project area). Please note that these maps do *not* show all fossils that are present at surface within the study area. Additional, unrecorded fossil occurrences (the majority) are to be expected in the subsurface, where they may be impacted during the construction phase of the development. Areas on the map that do not contain known fossil sites are therefore not necessarily fossil-free or palaeontologically insensitive.

1.5. Assumptions

Since most fossils are buried beneath the surface, their nature and distribution cannot be directly assessed during field surveys of the development footprint. Palaeontological assessments therefore rely on extrapolating palaeontological sensitivities within the footprint from desktop data and field surveys of well-exposed sedimentary rocks, mostly from sites *outside,* and often well away from, the footprint itself. This approach assumes that the rock exposures seen are representative - in palaeontological terms - of the rock units (formations, members *etc*) that will be impacted by the proposed development.

1.6. Limitations of this study

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 computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

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.

In the case of the Maralla West WEF and Maralla East WEF powerline study area near Sutherland in the Northern Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation. However, bedrock exposure is highly constrained by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (Central Mountain Shale Renosterveld, Koedoesberg – Moordenaars Karoo, Tanqua Wash Riviere). Much of the study area is is hilly or mountainous with few access roads, especially in rugged upland areas. However, sufficient bedrock exposures were examined during the course of several field studies in the Klein-Roggeveldberge region to assess the palaeontological heritage sensitivity of the main rock units represented within the grid connection project area (See reference list). Confidence levels for this impact assessment are consequently rated as Medium.

1.7. 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)**

2. DESCRIPTION OF THE PROJECT

The company BioTherm Energy (Pty) Ltd (BioTherm) is proposing to develop two wind energy facilities (WEFs), each with a total generation capacity of up to 140 MW, to be known as the Maralla West WEF and the Maralla East WEF, on adjacent sites located in the Klein-Roggeveldberge region some 30-40 km to the south of Sutherland, Northern Cape Province. Separate combined desktop and field-based palaeontological heritage assessments for the Maralla West and Maralla East WEFs have been submitted previously by Almond (2016h, 2016i) as part of the EIAs for these projects which has subsequently been authorised (DEA Refs. 14/12/16/3/3/2/962 for Maralla East WEF and 14/12/16/3/3/2/963 for Maralla West respectively). It was originally planned to connect the two WEFs to the national electricity grid *via* the existing Eskom Komsberg Main Transmission Substation situated to the southwest of the WEF project areas on Farm Standvastigheid 210, Northern Cape Province (*cf* Almond 2015b) (Fig. 1). The originally grid connection to Komsberg Substation was assessed at a desktop level by Almond (2017) and subsequently authorised (DEA Ref: 14/12/16/3/3/1/1774).

Three new, much shorter 132 kV grid connection options feeding into the Karusa WEF substation on De Hoop 202 together with associated access roads are now under consideration. They are referred to

as Option 1A, 1B and 2A, indicated in blue, white and yellow respectively in Figure 1, and range approximately from 17.5 to 19 km in length.

Land parcels within the Sutherland Magisterial District of the Northern Cape that are traversed by the proposed 132 kV powerlines, depending on the final route chosen, include: Drie Roode Heuwels RE/180, Zwanepoelshoek RE/184, Remainder and Portions 1 and 2 of Farm 203 (Orange Fountein), RE/203 of Farm Orange Fountain, Remainder of Farm 206 (Kentucky), Portions 1-3 of Farm 207 (Wolvenkop), RE/204 of Farm Schalkwykskraal and Remainder of De Hoop 202.

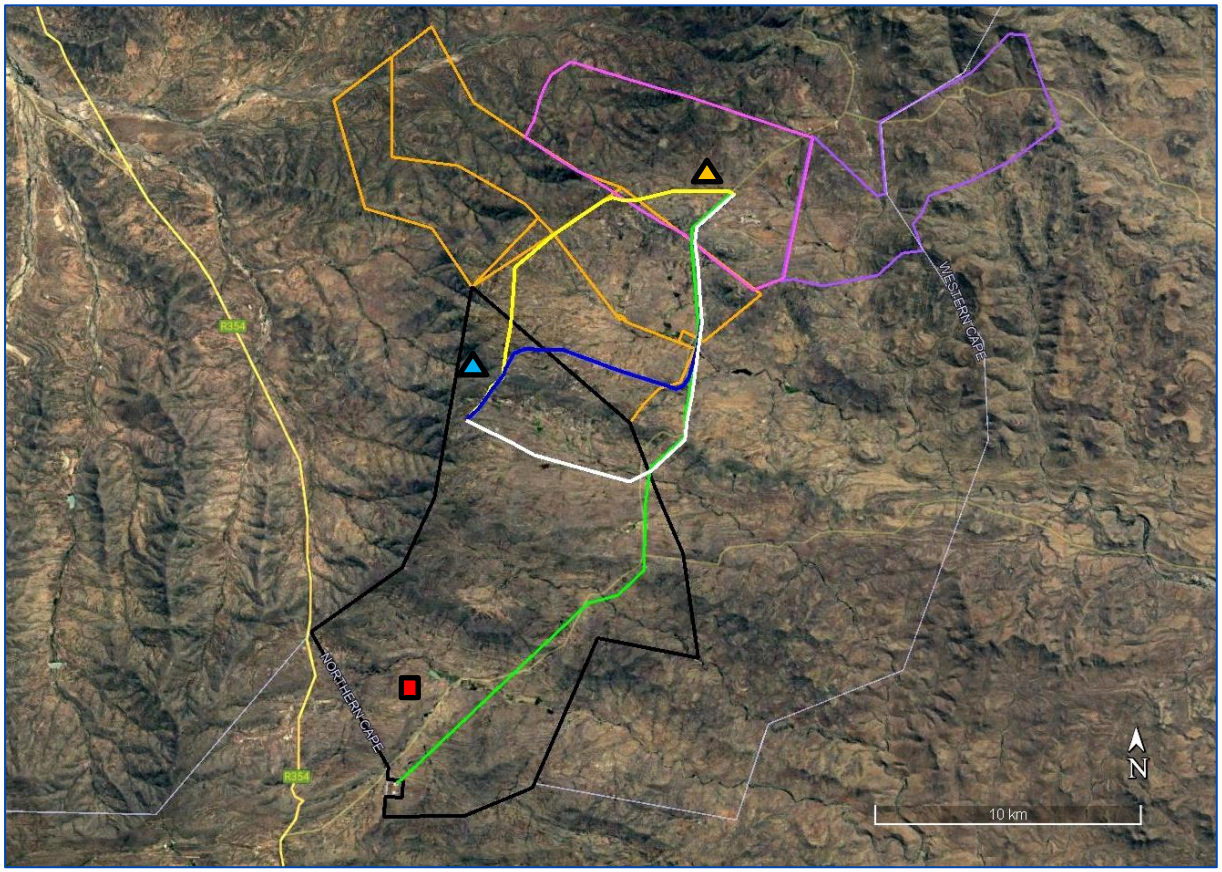

Figure 1: Google Earth© satellite image of the Klein-Roggeveldberge region *c*. 40 km south of Sutherland showing the adjoining project areas of the Maralla East WEF (purple), Maralla West WEF (lilac), Soetwater WEF (orange) and Karusa WEF (black). The approved grid connection from the Maralla substation (orange triangle) to the existing Komsberg MTS (red square) is shown in green. Three new 132 kV grid connection options feeding into the new Karusa Substation (red triangle) are now under consideration: Option 1A (blue), Option 1B (white) and Option 2A (yellow).

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Maralla West and Maralla East WEF 132 kV grid connection project area is situated in semi-arid, hilly to mountainous terrain of the Klein-Roggeveldberge region in the south-western part of the Great Karoo. It runs on both sides of the unpaved road between the R354 and the Komsberg Pass and falls entirely within the Northern Cape Province (Figure 1). The area is traversed by several WNW-ESE trending uplands (*e.g.* Smoushoogte – Perdeplaas se Berg, Graskop) and is drained by SE-flowing tributaries of the Buffelsrivier such as the Oshoke, Komsbergrivier and Meintjiesplaasrivier as well as a number of smaller, unnamed drainage courses. The level of bedrock exposure in the study region is highly constrained by extensive superficial deposits, especially in areas of low relief, as well as pervasive Karoo *bossieveld* vegetation (Central Mountain Shale Renosterveld, Koedoesberg – Moordenaars Karoo, Tanqua Wash Riviere). Representative views of the scenery, geology and topography in the present study area together with explanatory legends are given in Figures 2 to 11.

Figure 2: A thick channel sandstone package is exposed in the dissected, west-facing Klein-Roggeveldberge escarpment on De Hoop 202, Perdeplaas se Berg ridge. These resistant-weathering bedrocks underlie the hilly plateau towards the east where the Maralla grid connection project area is situated. Mudrock packages between the channel sandstone bodies are generally poorly-exposed apart from along occasional narrow stream gullies.

Figure 3: Stream gulley exposure of gently dipping maroon mudrocks on the southern slopes of Perdeplaas se Berg, De Hoop 202, close to the grid Option 1A and Option 2A routes. Good exposures of Abrahamskraal Formation mudrocks are a primary focus of palaeontological surveys.

Figure 4: View northwards towards an east-west trending ridge on the SE margins of Orange Fontein 203 showing typical stepped topography generated by a major sandstone package. Grid Option 1A would run across the southern footslopes of this ridge.

Figure *5: View northwards from the Perdeplaas se Berg across the western sector of Orange Fontein 203. Grid Option 2A would cross the low relief terrain in the middle ground where bedrock exposure is minimal due to thick cover by Late Caenozoic superficial deposits.

Figure 6: Thick package of purple-brown overbank mudrocks exposed in hillslopes and stream gullies west of Haashoogte, Drie Roode Heuwels 180, just west of the Grid Option 1 routing. Such exposures are ideal for palaeontological recording, but in this case have not yielded any notable fossil remains.

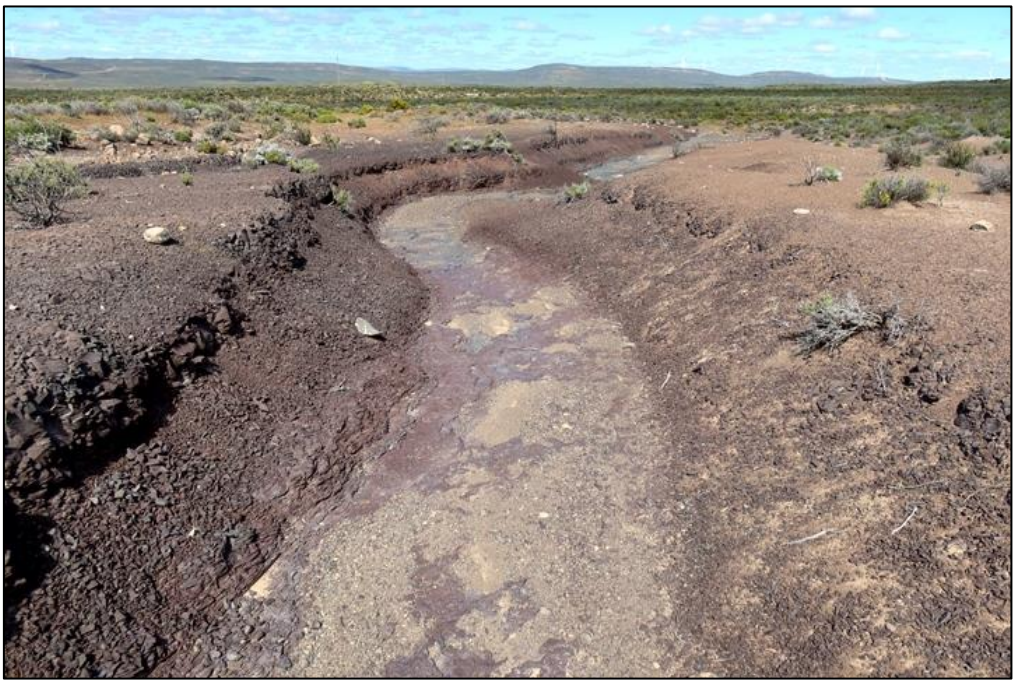

Figure 7: Shallow stream gulley incising maroon mudrocks to the south of the prominent *koppie* Graskop, NE margins of Orange Fontein 203.

Figure 8: View southwards from Perdeplaas se Berg towards the new Karusa WEF substation on De Hoop 202. Grid Options 1A and 2A will traverse the low-relief terrain in the middle ground where bedrock exposure is very limited.

Figure 9: Region on De Hoop 202 just north of the Karusa WEF substation showing the extensive surface disturbance associated with the construction of even small powerlines.

Figure 10: Close-up of a recently emplaced electrical pylon footing on the Karusa WEF. Recording of fossils within recently excavated rock rubble is rarely effective.Excavations for pylon footings are likely to have less impact on accessible fossil heritage than construction of the associated new access roads (see previous and following figures).

Figure 11: New powerline access routes running north from the Karusa WEF substation. Grid Options 1A and 2A would follow a similar corridor. Access roads in this area will mainly impact low palaeosensitivity superficial deposits.

3.1. Geological context

The geology of the Maralla WEF grid connection project area is outlined on the 1: 250 000 geology sheet 3220 Sutherland (Council for Geoscience, Pretoria; Theron 1983, Cole & Vorster 1999) (Figure 12) and illustrated in Figures 13 to 32 below. Geologically it lies on the gently-folded northern margin of the Permo-Triassic Cape Fold Belt (CFB) and is dominated by bedrocks of the Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup) within the Main Karoo Basin (Johnson *et al.* 2006). Gentle folding along west-east trending fold axes of Lower Beaufort Group bedrocks is apparent within the study area. In general bedding dips are not high, however (5 to 12 degrees on geological map), and levels of tectonic deformation are usually low with only local cleavage development. Several WNW-ESE or W-E trending faults cutting the Lower Beaufort Group succession can be picked out on satellite images by bush clumps and sharp bedding discontinuities but many of these are not shown on the geological map. These narrow lines may be locally associated with narrow dolerite dykes but these were not observed during the site visit.

Illustrated descriptions of the Lower Beaufort Group bedrocks as well as various superficial sediments within the Maralla WEF grid connection study area – with the notable exception of the Great Karoo WEF project area - have been given in the PIA reports for the Maralla West WEF, Maralla East WEF, Karusa WEF and Soetwater WEF listed in the References. Further representative exposures of the main rock units represented within the Maralla grid connection project area are illustrated in Figures 13 to 32 in this report, together with short explanatory figure legends.

Only one mappable bedrock unit or formation is represented within the study area, *viz*. fluvial, delta platform and lacustrine mudrocks and sandstones of the **Abrahamskraal Formation** (**Lower Beaufort Group / Adelaide Subgroup**) of Middle Permian age (*cf* Johnson *et al.* 2006, Day and Rubidge 2014, Wilson *et al.* 2014, Cole *et al.* 2016 and references therein). The specific stratigraphiic members of Abrahamskraal Formation represented within the study area have not yet been identified with confidence; they *might* belong largely to the Leeuvlei Member - Koornplaats Member stratigraphic interval of Loock *et al*. (1994) and Day and Rubidge (2014) (Fig. 33). The Lower Beaufort Group beds crop out over the great majority of the powerline study area (Pa, pale green in Figure 12). However, exposure levels of these sedimentary bedrocks are generally very low and mainly confined to stream gullies, steeper hillslopes as well as occasional borrow pits (Figs. 2 to 8, 13 to 30).

A delta platform or distal, well-watered floodplain setting with frequent high water tables is suggested for the lowermost Abrahamskraal Formation beds by abundant upward-coarsening sedimentary packages, gradational and loaded tabular sandstone bases without gullying or well-developed channel breccio-conglomerates, possible pipe- or dyke-like dewatering structures, dark grey or grey-green (but not reddish), laminated to massive mudrocks, frequent horizons of large, rusty-brown concretions and lenses of diagenetic ferruginous carbonate (sometimes containing dispersed mud chips) as well as fossil assemblages dominated by equisetalean ferns and lungfish burrows, with no skeletal remain of land-living tetrapods recorded so far (*cf* Almond 2021). Drier climatic conditions on the floodplain of large meandering river systems are also well represented in the present project area. This is suggested by the greater frequency higher in the Abrahamskraal succession of maroon mudrocks with occasional horizons of small, grey pedogenic calcrete (arid climate palaesols) as well as sand-infilled mudcracks and channel sandstone bodies with sharp gullied bases and lenses of well-developed, often ferruginised breccio-conglomerate dominated by reworked calcrete glaebules. Horizons with abundant gypsum pseudomorphs (“desert roses”) witness the intermittent evaporation of water bodies. Occasional float blocks of pale yellowish-green tuffite are noted within the project area but the tuffite horizons themselves were not found *in situ*; these rocks have important potential for dating subunits of the Lower Beaufort Group (*cf* Lanci *et al.* 2013).

Levels of bedrock exposure in the Klein-Roggeveldberge region are generally very low due to the pervasive mantle of **Late Caenozoic superficial deposits** such as alluvium, colluvium (scree, hillwash), eluvium / surface gravels, pedocretes (*e.g.* calcrete) and soils, as well as karroid *bossieveld* vegetation (Figs. 31 & 32). Most of these deposits are of Late Neogene or Quaternary to Holocene age. They have not been mapped at 1: 250 000 scale within the Maralla WEF substation and powerline project area. The majority of powerline pylon footings are likely to be excavated into relatively unfossiliferous superficial sediments rather than the underlying Lower Beaufort Group bedrocks.

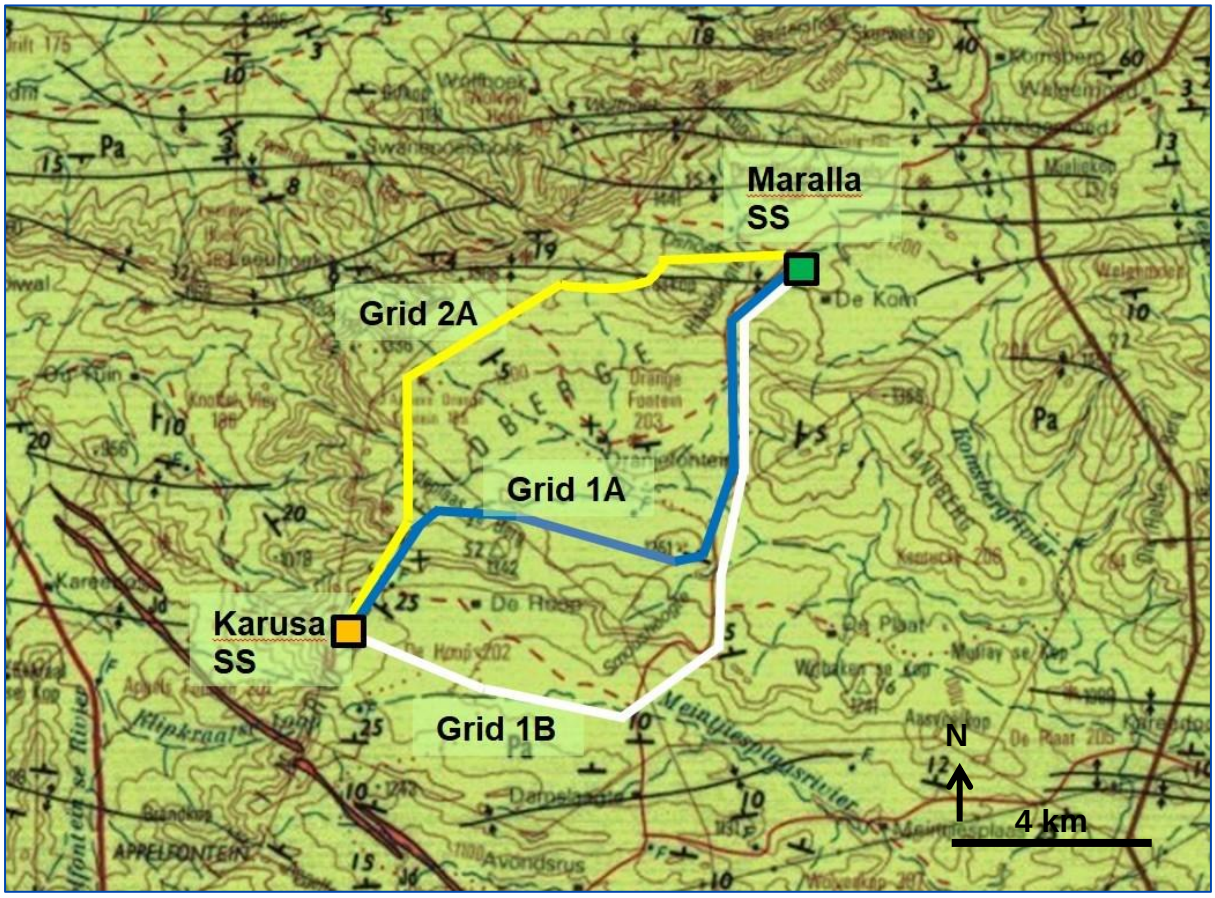

Figure 12. Extract from the 1: 250 000 scale geology sheet 3220 Sutherland (Council for Geoscience, Pretoria) showing the *approximate* routes of the three 132 kV grid connection route options from the Maralla on-site substation to the new Karusa WEF substation situated in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland, Northern Cape. The main mappable rock units represented within the study area are:

LOWER BEAUFORT GROUP **Abrahamskraal Formation (Pa, pale green)**

KAROO DOLERITE SUITE **Karoo dolerite (Jd, red lines)**

Various Late Caenozoic superficial deposits that are *not* here mapped at 1: 250 000 scale include alluvium, colluvium (scree deposits, hillwash), eluvial / downwasted surface gravels, pedocretes (calcretes) and skeletal soils.

Figure 13: Cliff exposure through a major, multi-storey channel sandstone body on Kentucky 206, close to the powerline Option 1B route.

Figure 14: Stepped, west-facing hillslope exposure of a major channel sandstone package on the western footslopes of Ruiter se Kop in the eastern sector of Orange Fontein 203, close to the powerline Option 1A and 1B routes.

Figure 15: Thick-bedded, coarse-grained channel sandstone with associated apron of well-rounded, boulder-sized eluvial corestones, Abrahamskraal Formation, Ruiter se Kop, Orange Fontein 203. Several archaeological sites with LSA stone artefacts occur among the boulders here.

Figure 16: Bouldery corestones on the footslopes of Ruiter se Kop, Orange Fontein 203, show evidence of karstic (solution) weathering and case hardening as well as lichen weathering.

Figure 17: Low-angle tabular cross-bedding or horizontal lamination within channel sandstones on Ruiter se Kop (Hammer = 30 cm).

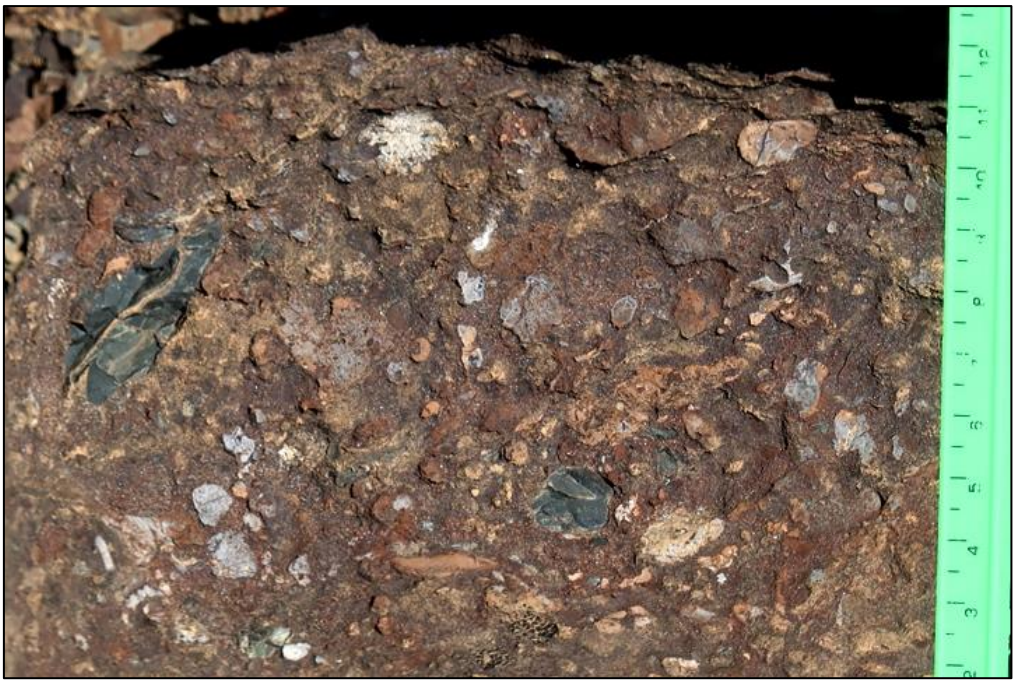

Figure 18: Close-up of a block of ferruginised breccio-conglomerate composed of reworked, angular to subrounded clasts of calcrete (paler) and mudrock (darker) eroded from the ancient Karoo floodplain during periods of channel incision (scale in cm). Such breccias are locally developed at or towards the base of erosive-based channel sandstone bodies in the project area and are a target for fossil recording (*e.g.* reworked fossil wood, bones, teeth).

Figure 19: Deep-penetrating, sand-infilled desicccation cracks within purple-brown overbank mudrocks indicating highly arid climatic intervals on the ancient floodplain, same locality as previous figure (hammer = 30 cm).

Figure 20: Margins of a lenticular channel sandstone body sharply incised into dark, thin-bedded overbanks siltstones, gulley exposure on Drie Roode Heuwels 181.

Figure 21: Thin, lenticular channel sandstone body with an extensively gullied base exposed in a stream bank close to the Maralla substation site on the eastern sector of Drie Roode Heuwels 180.

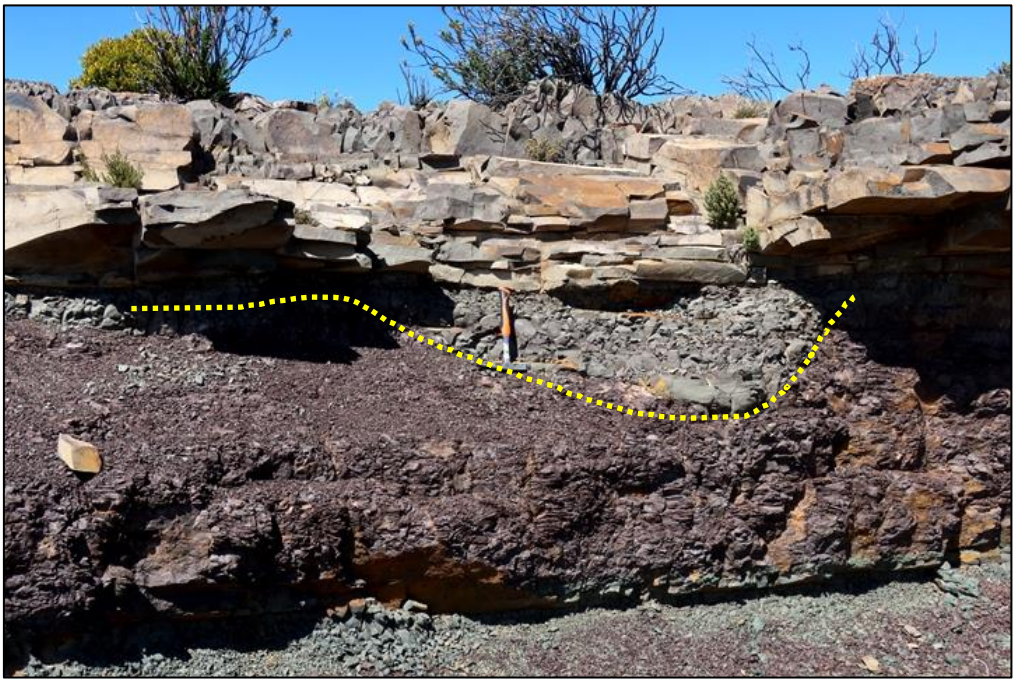

Figure 22: Detail of the thin-bedded channel sandstone seen in the previous figure, showing a basal erosional gulley infilled with grey-green wacke (yellow dotted line) incising maroon overbank mudrocks (Hammer = 30 cm).

Figure 23: Stream bank exposure through dark, grey-green overbank mudrocks capped by a tabular channel sandstones with small-scale lenticular channel fills beneath (arrowed), Orange Fontein 203, close to powerline Options 1A and 1B.

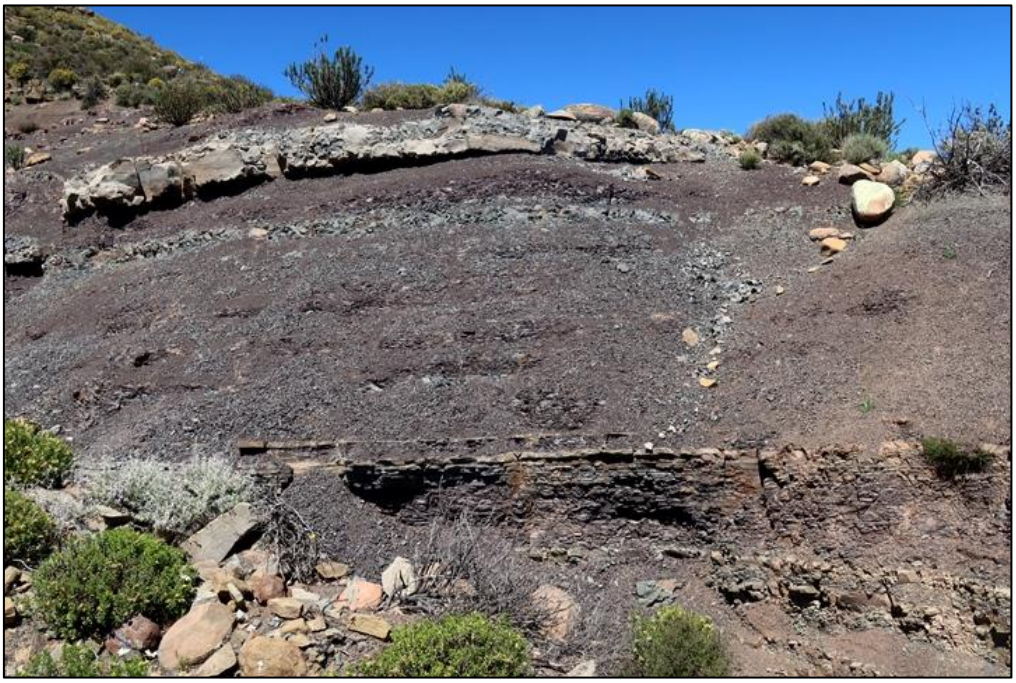

Figure 24: Steep gulley sections through maroon overbank mudrocks with thin crevasse-splay sandstones on the footslopes of Ruiter se Kop, Orange Fontein 203.

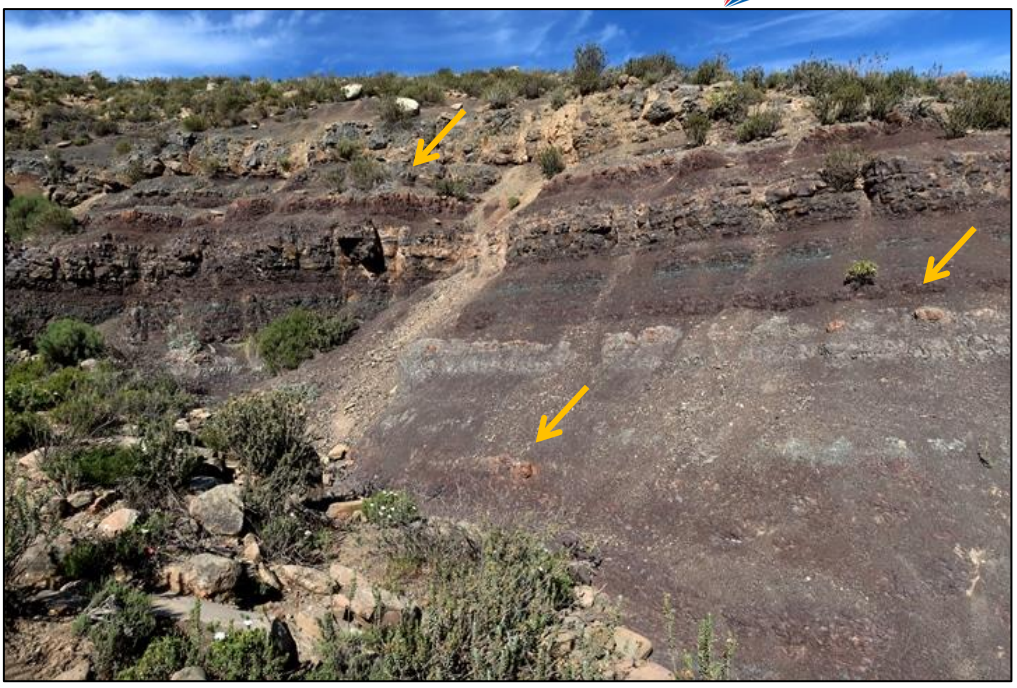

Figure 25: Excellent subvertical sections through grey-green and purple-brown mudrock facies with several horizons of ferruginous carbonate diagenetic concretions (arrowed), gully on the southern slopes of Graskop, Orange Fontein 203.

Figure 26: Dark grey-green mudrocks of possible lacustrine facies showing ball-and-pillow structures generated by loading of a denser fine-grained sandstone (hammer = 30 cm), southern slopes of Graskop, Orange Fontein 203.

Figure 27: Thin horizon of greyish pedogenic calcrete concretions marking a palaeosol (fossil soil) within maroon overbank mudrocks, stream gulley exposure due south of Graskop, northern sector of Orange Fontein 203. Note also cover by coarse eluvial gravels of channel wacke (Hammer = 30 cm).

Figure 28: Good hillslope exposure of gently dipping Abrahamskraal Formation mudrocks and thin crevasse-splay sandstones on Drie Roode Heuwels 180.

Figure 29: Erosion gulley exposure of strongly, multi-hued Abrahamskraal Formation mudrocks and wackes on the southern slopes of Perdeplaas se Berg, De Hoop 202.

Figure 30: Steeply inclined tectonic cleavage developed within folded mudrock and wacke facies, same locality as previous figure (hammer = 30 cm). Cleavage indicates locally higher levels of tectonic deformation that does not favour fossil preservation.

Figure 31: Thick, well-bedded apron of coarse gravelly to sandy colluvial deposits mantling the Abrahamskraal Formation bedrocks on the footslopes of Ruiter se Kop, Orange Fontein 203. These unconsolidated cover sediments are generally of low palaeosensitivity.

Figure 32: Thick, fine-grained alluvial deposits extensively dissected by gulley erosion, Drie Roode Heuwels 180. Superficial sediments of this sort, with coarser basal gravels, mantle much of the lower-lying, low-relief terrain within the grid connection project area. Calcretised older alluvial and coluvial deposits in the Karoo region may contain important fossil remains (bones, teeth, horncores) of Quaternary mammals, but these are usually rare.

4. PALAEONTOLOGICAL HERITAGE

The Great Karoo is world-famous for its rich record of terrestrial vertebrates and other fossils from the Permian, Triassic and Early Jurassic Periods in Gondwana (Rubidge 1995, MacRae 1999, Rubidge 2005, McCarthy & Rubidge 2005, Smith *et al.* 2012). The fossil record of the Klein-Roggeveldberge region is very poorly known by Karoo standards but our knowledge has been improved in recent years through several palaeontological impact assessments in the area.

Some of the principal fossil sites recorded during recent field studies for various WEF projects in the vicinity of the Maralla 132 kV grid connection corridors under consideration, together with additional new sites recorded during the recent 3-day palaeontological survey, are indicated on the satellite image of the project area in Figures A1.1 and A1.2 (Appendix 1). Sparse, newly recorded fossil material from the 2021 site visit illustrated in Figures 34 to 41 belongs to the same taxa as previously reported in the area. The fossil database has been abstracted from the relevant PIA reports by the author (See References) where the fossil material is illustrated and briefly described, while detailed locality data is tabulated in the report Appendices. Please note that these are *not* distribution maps of *all* fossil occurrences within the project area – most of which are not exposed at the surface – but only a representative sample of the better-preserved fossils encountered during the field assessments. Further, unrecorded fossil occurrences are to be expected elsewhere at the ground surface or in the subsurface (the majority), where they may be impacted during the construction phase of the powerline. Areas on the map that do not contain known fossil sites are therefore not necessarily fossil-free or palaeontologically-insensitive. The great majority of the fossils observed are of widely-occurring forms and are not considered to be of exceptional scientific or conservation value.

The Abrahamskraal Formation beds represented within the present powerline and substation study area broadly young towards the northeast and are *provisionally* assigned to the Leuuvlei and Koornplaats Members of Middle Permian age. These successions are characterised by vertebrate and other fossils of the *Tapinocephalus* Assemblage Zone (Loock *et al.* 2009, Smith *et al.* 2012, Day & Rubidge 2014, Day & Rubidge 2020) (Fig. 33). Sparse fossil remains recorded from the Abrahamskraal Formation in the vicinity of the Maralla 132 kV powerline corridors are dominated by low-diversity trace fossil assemblages (invertebrate burrows such as *Scoyenia*, casts of reedy plant stems) and plant compressions, casts and moulds that are probably attributable to horsetail ferns (sphenophytes). There are also a few recorded occurrences of petrified wood (mainly poorly-preserved, perhaps due to partial microbial decomposition before silicification) that are found as float blocks or associated with channel sandstone basal breccio-conglomerates, particularly within the (inferred) Koornplaats Member. Vertebrate fossils are very rare, comprising several, often equivocal tetrapod and lungfish burrow casts (*Dipnoichnus*) as well as occasional fragmentary remains of unidentified tetrapod bones (probable amphibians). The fairly common horizons of horsetail fern debris, *Scoyenia* invertebrate burrows associated with wave-rippled sandstone bed tops as well as occasional lungfish burrow casts suggests that lacustrine and swampy wetland settings were well represented on the floodplain or in abandoned river channels in the Middle Permian Karoo Basin.

No fossil remains are recorded from the pervasive Late Caenozoic superficial sediments mantling the majority of the Lower Beaufort Group outcrop area within the broader study region, including the Maralla West, Maralla East, Soetwater and Karusa WEF project areas. It is concluded that the overall palaeontological sensitivity of the 132 kV grid connection corridors for the Maralla WEFs is low.

It is noted that the great majority of the fossils observed so far within the Maralla grid connection project area are of widely-occurring forms that are not considered to be of exceptional scientific or conservation value. None of the known fossil sites recorded during the 2021 and previous palaeontological site visits lies within the footprints (or buffer zones) of the 132 kV powerline route options under consideration

(see satellite maps in Appendix 1, Figures A1.1 and A1.2). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

Site 571 features downwasted fragments of petrified wood as well as ferruginised moulds of woody plant stems which have probably weathered out from breccias within the base of thick channel sandstone body upslope and are of low scientific / conservation significance (Proposed Field Rating IIIC) (See Figs. 45 to 47 in Almond 2015d). Concentrations of LSA flaked artefacts also occur in the vicinity (chert, fine sandstone, vein quartz). The site lies close to but *c*. 40 m east of the powerline Option 1A / 1B route and is therefore unlikely to be impacted by the powerline.

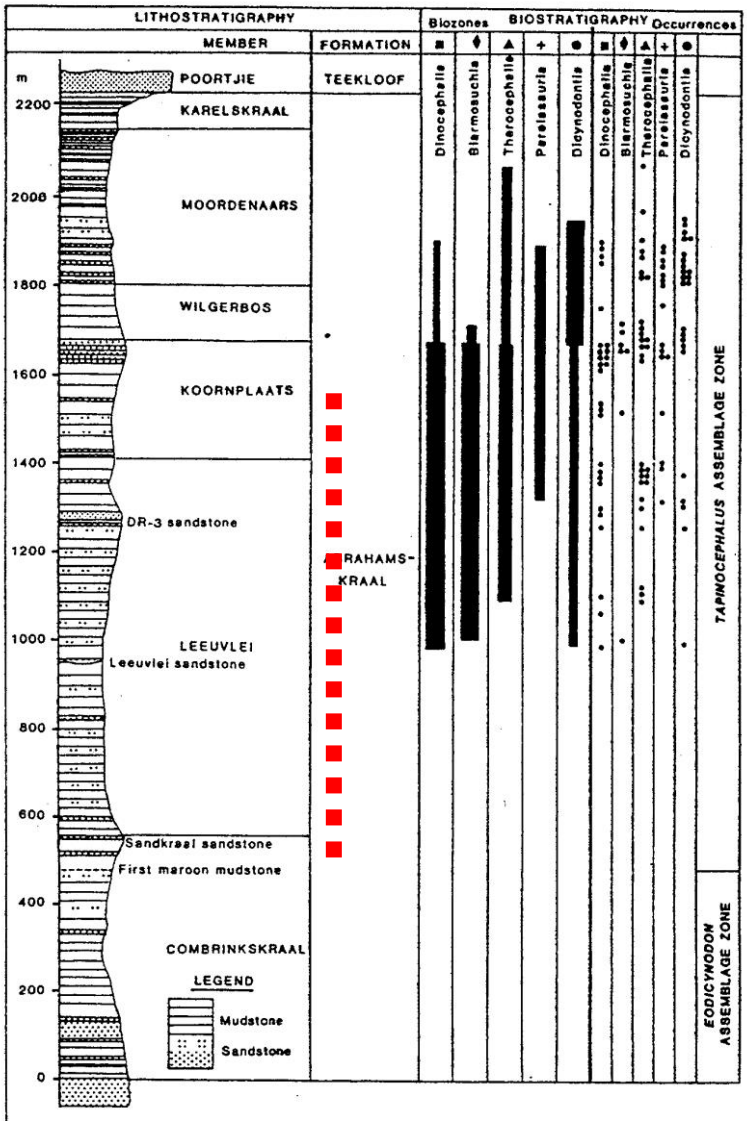

Figure 33: Chart showing the subdivision of the Abrahamskraal Formation in the western Karoo region with stratigraphic distribution of the major fossil vertebrate groups (Loock *et al*. 1994). The powerline and on-site substation study area for the Maralla East and Maralla West WEFs is underlain by Middle Permian sediments which are *provisionally* inferred to belong to the Leeuvlei and Koornplaats Members (red dotted bar) that are characterized by fossils of the *Tapinocephalus* Assemblage Zone. However, the great scarcity of vertebrate fossil remains within the project area may suggest that only the lower portion of the Leeuvlei succession may be represented here (alternatively, very poor bedrock exposure may be responsible).

Figure 34: Isolated weathered-out block (9 cm across) of poorly-preserved, silicified fossil wood (possibly partially decomposed before preservation) within surface gravels, De Hoop 202 (Loc. 497).

Figure 35: Rusty-brown moulds of woody plant axes preserved within basal channel sandstone, De Hoop 202 (Loc. 505).

Figure 36: Several channel sandstone blocks containing moulds of reworked woody plants, same locality as previous figure (scale is 15 cm long).

Figure 37: Wacke with veneer of purple-brown siltstone perforated by rounded to irregular casts of probable invertebrate burrows and / or reedy plant stems, Drie Roode Heuwels 180 (Loc. 522) (scale is 15 cm long).

Figure 38: Upper bedding surface of grey wackes with round sandstone casts of reedy plant stems (*c*. 1 cm diam.), Orange Fontein 203 (Loc. 533).

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Figure 39: Stream bed exposure of wave-rippled wacke bed top with effaced horizontal invertebrate burrows - probably *Scoyenia* - Drie Roode Heuwels 190 (Loc. 520) (scale is 15 cm long). *Scoyenia* burrows were probably made by arthropods (possibly insects) and are usually associated with damp substrates, for example around lake margins.

Figure 40: Brownish to grey-green wackes with veneer of purple-brown siltstone perforated by rounded to irregular casts of probable invertebrate burrows and / or reedy plant stems up to *c*. 2 cm across, Drie Roode Heuwels 180 (Loc. 526).

Figure 41: Mottled, bioturbated grey and purple-brown wacke containing ill-defined subcylindrical invertebrate burrows, Drie Roode Heuwels 180 (Loc. 522) (scale is 15 cm long).

5. ASSESSMENT OF IMPACTS

Given the very uniform underlying geology (and hence expected palaeontological resources), this Basic Assessment applies equally to all the 132 kV grid connection corridors under consideration.

All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils may not be collected, damaged or disturbed without a permit from the relevant Provincial Heritage Resources Agency (in this case Heritage Western Cape) (See Section 1.3). The construction phase of the proposed 132 kV powerline will entail extensive surface clearance (notably for access roads, pylon footings) as well as excavations into the superficial sediment cover and possibly also into the underlying bedrock, albeit to a limited extent (*e.g. for* pylon footings). The development may adversely affect potential fossil heritage within the study area by destroying, damaging, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The operational and de-commissioning phases of the transmission integration infrastructure are very unlikely to involve further adverse impacts on local palaeontological heritage and are therefore not separately assessed here. Based on experience with WEFs currently under construction, the main source of potential impacts on palaeontological heritage due to grid connection projects is the construction of new access roads, especially in hilly terrain (*cf* Figs. 8 to 11).

5.1. Current impacts on site

Due to slow-acting natural weathering and erosion processes in a semi-arid Karoo setting, where rates of erosion usually exceed rates deposition, fossils already exposed at the ground surface are being gradually destroyed while new, previously buried fossils are being exposed and “prepared out”. Farming activities within the project area have a minimal impact on local palaeontological heritage resources. Fossil collection by qualified palaeontologists or (illegal) amateurs is probably negligible.

5.2. Impact assessment for the construction phase

This assessment (See Table A3.1 in Appendix 3) refers to impacts on fossil heritage preserved at or beneath the ground surface within the footprint of 132 kV powerlines during the construction phase, mainly due to surface clearance and excavation activities. It is noted that surface clearance for lengthy access roads associated with new powerlines is likely to have greater impact on fossil heritage than the intermittent, shallow excavations for pylon footings (See Figs. 8 to 11). Such impacts on fossil heritage are *limited to the site* (development footprint) and are generally *direct*, *negative* and of *permanent* effect (*irreversible*). While fossils of some sort (including microfossils, invertebrate trace fossils and plant debris) are of widespread occurrence within the project area, unique or scientifically-important fossils are very scarce indeed here, even where bedrock exposure levels are locally high. No highly-sensitive no-go areas have been identified within the Maralla grid connection study area. It is concluded that impacts on *palaeontological heritage resources of scientific and / or conservation value* are of *low probability* and of *low magnitude* since (1) significant fossil sites are unlikely to be affected and (2) in many cases these impacts can be mitigated through the proposed Chance Fossil Finds Protocol (Appendix 2). The overall impact significance during the construction phase of the powerline infrastructure *without mitigation* is rated as LOW (NEGATIVE) in terms of palaeontological heritage resources. Should the proposed mitigation measures outlined in Section 6 below be fully implemented, the impact significance would remain LOW (NEGATIVE). However, residual negative impacts such as the inevitable loss of fossil heritage would be partially offset by an improved understanding of Karoo fossil heritage which is considered a *positive* impact.

There are no objections on palaeontological heritage grounds to authorisation of the proposed 132 kV transmission integration project, including 132 kV powerline and associated infrastructure. Given the paucity of high-sensitivity fossil sites recorded within the Maralla grid connection project area and the fairly uniform bedrock geology here, there is no preference on palaeontological grounds for any particular one of the three 132 kV grid connection options under consideration. All the new powerline options to the Karusa Substation are likely to have a lower impact significance than the considerably longer approved connection to the Komsberg Substation.

Confidence levels for this assessment are rated as *medium*, given the number of palaeontological field studies that have been carried out within the broader Klein-Roggeveldberge study region, including several site visits to various portions of the Maralla grid connection project area (See References).

The impact assessment for the **No-Go Option** considers future impacts on local fossil heritage that are likely to occur in the absence of powerline development, using the present status of fossil heritage in the area as a baseline. Destruction of near-surface or surface fossil material by natural bedrock weathering and erosion will be partially counterbalanced by on-going exposure of fresh fossil material by erosion. Improvements in our understanding of palaeontology of the area (a possible positive impact) will depend on whether or not field-based academic or impact studies are carried out here, which is inherently unpredictable (There is an on-going research project on the palaeontology of the Abrahamskraal Formation in the SW Karoo by Wits University). On balance, the No-Go Option may have a *neutral* impact significance

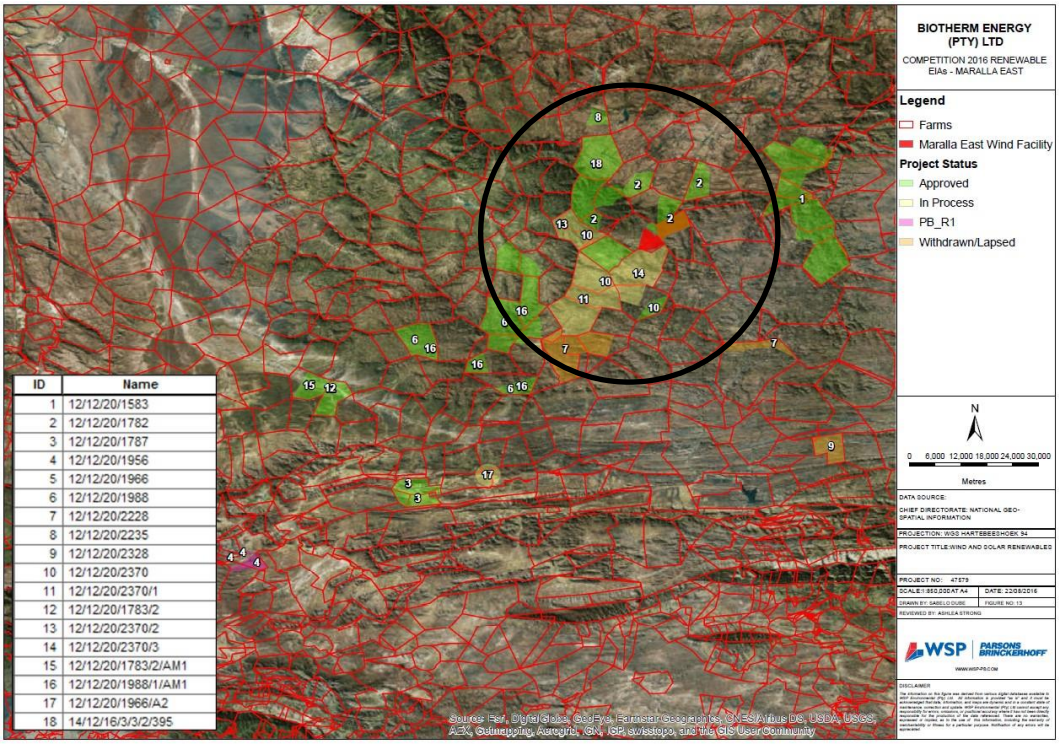
5.2. Assessment of cumulative impacts (construction phase)

Cumulative impacts inferred for the various alternative energy developments in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland have been previously assessed by Almond (2016i) on the basis of desktop and field-based palaeontological impact assessment reports for these projects, the great majority of which were submitted by the present author (See references provided below and SAHRIS website). The projects concerned lie within a radius of some 50-70 km of the Maralla WEF project area. WEF projects within a smaller, 30 km radius of the Maralla grid connection project are highlighted by the black circle in Figure 42 while existing Eskom powerlines in the vicinity of the Esizayo WEF grid connection project area are shown in Figure 43. Relevant published palaeontological literature for the region has also been taken into account (*e.g.* Loock *et al.* 1994). This assessment applies only to the construction phase of the WEF powerline development, since significant additional impacts on palaeontological heritage during the operational and de-commissioning phases are not anticipated.

In all the strictly *relevant* field-based palaeontological studies in the Klein-Roggeveldberge region the palaeontological sensitivity of the project area and the palaeontological heritage impact significance for the developments concerned has been rated as low. In all cases it was concluded by the author that, despite the undoubted occurrence of scientifically-important fossil remains (notably fossil vertebrates, vertebrate trackways and burrows, petrified wood), the overall impact significance of the proposed developments was low because the probability of significant impacts on scientifically important, unique or rare fossils was slight. While fossils do indeed occur within some of the formations present, they tend to be sparse – especially as far as fossil vertebrates are concerned - while the great majority represent common forms that occur widely within the outcrop areas of the rock units concerned.

Cumulative impacts for the Maralla WEF 132 kV powerline in the context of comparable alternative energy projects proposed or authorised in the Klein-Roggeveld region are assessed in Table 2. It is

concluded that the cumulative impact significance of the proposed new developments and other regional projects is *low* (*negative*), *provided* that the proposed monitoring and mitigation recommendations made for all these various projects are followed through. Unavoidable residual negative impacts may be partially offset by the improved understanding of Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a *positive* impact for Karoo palaeontological heritage. However, *without* mitigation the magnitude of cumulative (negative, direct) impacts of such a large number of WEFs affecting the same (albeit sparsely) fossiliferous rock successions would be significantly higher and probable. The cumulative impact significance without mitigation is accordingly assessed as *medium*.



ID	Name
1	12/12/20/1583
2	12/12/20/1782
3	12/12/20/1787
4	12/12/20/1956
5	12/12/20/1966
6	12/12/20/1988
7	12/12/20/2228
8	12/12/20/2235
9	12/12/20/2328
10	12/12/20/2370
11	12/12/20/2370/1
12	12/12/20/1783/2
13	12/12/20/2370/2
14	12/12/20/2370/3
15	12/12/20/1783/2/AM1
16	12/12/20/1988/1/AM1
17	12/12/20/1966/A2
18	14/12/16/3/3/2/395

Figure 42: Satellite image showing the large number of proposed WEF facilities in the Klein-Roggeveldberge region between Matjiesfontein and Sutherland. The black circle outlines those projects that lie within a *c*. 30 km radius of the Maralla West and Maralla East WEF projects (*cf* Table 1 below for details). PIA studies for most of these WEF projects have been conducted by the present author.

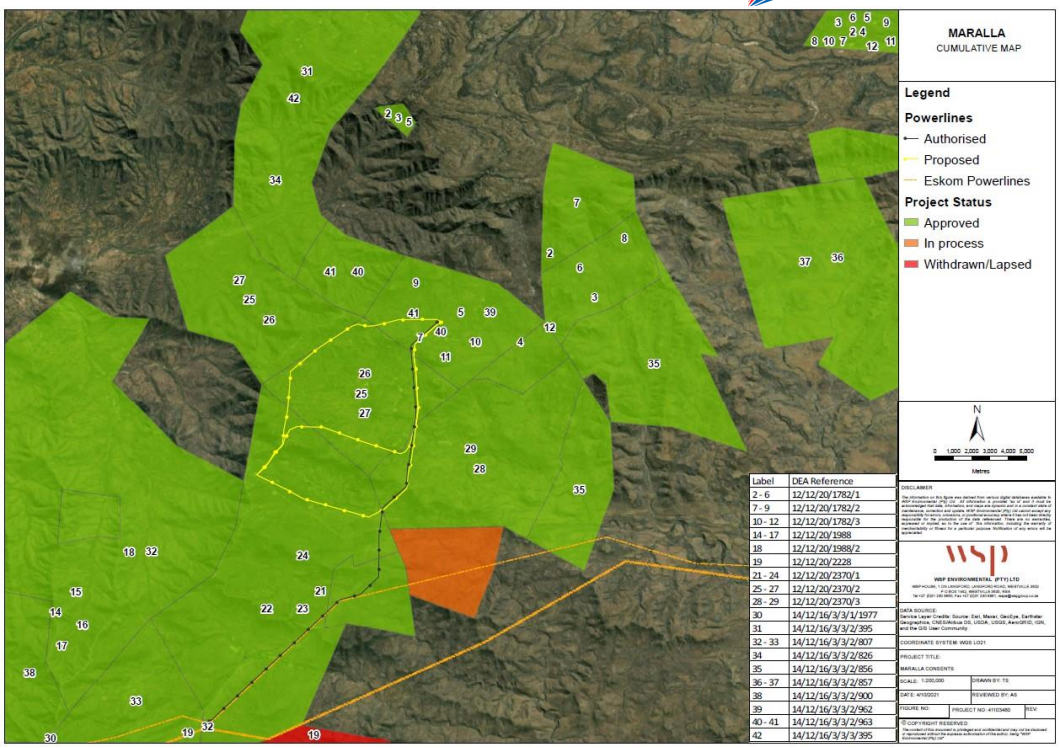


Figure 43: Grid connection options for the Maralla WEFs in the context of Eskom powerlines in the vicinity. Palaeontological data for grid connections to other WEF projects in the region is limited.

Table 1: WEF projects in the vicinity of the Maralla East and Maralla West WEFs and grid connection project area (DEEA database)

DEA_REF	EIA_PROCES	PROJ_TITLE	APPLICANT	PRJ_STATUS
12/12/20/1782/1	Amendment	140 Megawatts (MW) Rietrug Wind Energy Facility near Sutherland, Northern Cape Province	South Africa Mainstream Renewable Power Developments (Pty) Ltd	Approved
12/12/20/1782/2	Amendment	140 Megawatts (MW) Sutherland Wind Energy Facility near Sutherland, Northern Cape Province and Western Cape Provinces	South Africa Mainstream Renewable Power Developments (Pty) Ltd	Approved
12/12/20/1782/3	Amendment	140 Megawatts (MW) Sutherland 2 Wind Energy Facility near Sutherland Wind Energy, Northern Cape Province and Western Cape Provinces	South Africa Mainstream Renewable Power Developments (Pty) Ltd	Approved
12/12/20/1988	Scoping and EIA	Proposed Construction Of The 750 Mw Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	G7 Renewable Energies Pty Ltd	Approved
12/12/20/1988/2	Scoping and EIA	Proposed Construction Of The 140Mw Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	G7 Renewable Energies Pty Ltd	Approved
12/12/20/2228	Scoping and EIA	Proposed wind energy facility near Komsberg, Western Cape	INCA Komsberg Wind Pty Ltd	Withdrawn/Lapsed
12/12/20/2370/1	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern Cape	To review	Approved
12/12/20/2370/2	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern Cape	To review	In process
12/12/20/2370/3	Scoping and EIA	Proposed Hidden Valley wind energy facility , Northern Cape	To review	In process
14/12/16/3/3/1/1977	BAR	Proposed development of the 14MW Rietkloof wind energy facility and associated infrastructure near Matjiesfontein in the Western Cape	Rietkloof Wind Farm (Pty) Ltd	Approved
14/12/16/3/3/2/395	Scoping and EIA	Proposed 280 MW Gunstfontien Wind energy Facility, Northern Cape Province	Networx Eolos Renewables (Pty) Ltd	Approved
14/12/16/3/3/2/807	Scoping and EIA	The Proposed Karreebosch Wind Farm (Roggeveld Phase 2) and its Associated Infrastructure within the Karoo Hoogland Local Municipality and the Laingsburg Local Municipality in the Northern and Western Cape Provinces	Karreebosch Wind Farm (Pty) Ltd	Approved
14/12/16/3/3/2/826	Scoping and EIA	Environmental Authorisation for the 200 MW Gunstfontein Wind Energy Facility on the	Gunstfontein Wind Farm (Pty) Ltd	Approved

		Remainder of the Farm Gunstfontein 131 South of the Town of Sutherland Within the Karoo Hoogland Local Municipality In The Northern Cape Province		
14/12/16/3/3/2/856	Scoping and EIA	275 Komsberg West Wind Energy facility near Sutherland within the Karoo Hoogland and Laingsburg Local Municipalities in the Northern and Western Cape Provinces.	Komsberg Wind Farms (Pty) Ltd	Approved
14/12/16/3/3/2/857	Scoping and EIA	275 MW Komsberg East Wind Energy Facility near Sutherland within the Karoo Hoogland and Lainsgburg Local Municipalities in the Northern and Western Cape Provinces.	Komsberg Wind Farms (Pty) Ltd	Approved
14/12/16/3/3/2/900	Scoping and EIA	147MW Brandvalley Wind Energy Facility North of the town of Matjiesfontein within Karoo Hoogland	Brandvalley Wind Farm (Pty) Ltd.	Approved
14/12/16/3/3/2/962	Scoping and EIA	140MW Maralla East Wind Energy Facility in Lainsburg, Northern and Western Cape provinces	BioTherm Energy (Pty) Ltd	Approved
14/12/16/3/3/2/963	Scoping and EIA	140MW Maralla West Wind Energy Facility in Lainsburg, Northern and Western Cape Province	BioTherm Energy (Pty) Ltd	Approved
14/12/16/3/3/3/395	Amendment	Proposed renewable Gunstfontein Wind Energy Facility, Northern Cape Province	Networx Eolos Renewables (Pty) Ltd	Approved

6. MITIGATION AND MANAGEMENT MEASURES

Given the scarcity of scientifically-important, unique fossil heritage recorded within the grid connection project area, no further specialist palaeontological studies or mitigation are recommended for this development, pending the potential discovery of significant new fossils before or during the construction phase.

The following general palaeontological mitigation measures apply to the construction phase of the powerline (See Table 2):

- Monitoring of all surface clearance and substantial excavations (>1 m deep) by the ECO / ESO for fossil material (*e.g.* bones, teeth, fossil wood) on an on-going basis during the construction phase.

- Safeguarding of chance fossil finds (preferably *in situ*) during the construction phase by the responsible ECO / ESO, followed by reporting of finds to SAHRA.

- Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy) (Phase 2 mitigation).

- Curation of fossil material within an approved repository (museum / university fossil collection) and submission of a Phase 2 palaeontological heritage report to SAHRA by a qualified palaeontologist.

Mitigation of significant chance fossil finds reported by the ECO / ESO would involve the recording, sampling and / or collection of fossil material and associated geological data by a professional palaeontologist during the construction phase of the development (See summarized Chance Fossil Finds Protocol in Appendix 2). The palaeontologist concerned with potential mitigation work (Phase 2) would need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological fieldwork and reporting should meet the minimum standards outlined by HWC (2021) and SAHRA (2013).

Significant further impacts on palaeontological heritage resources are not anticipated during the planning, operational, decommissioning and rehabilitation phases of the grid connection so no further mitigation or management measures in this respect are proposed here.

These monitoring and mitigation requirements should be incorporated into the Environmental Management Programme (EMPr) for the proposed electrical infrastructure and also included as conditions for authorisation of the development.

Table 2 (following pages) : Recommended mitigation and management measures concerning palaeontological heritage for the Maralla WEF 132kV powerline.

ACTIVITY	MITIGATION AND MANAGEMENT MEASURE	RESPONSIBLE PERSON	APPLICABLE DEVELOPMENT PHASE	INCLUDE AS CONDITION OF AUTHORISATION	MONITORING REQUIREMENTS
Surface clearance & substantial excavations (> 1 m deep)	Monitoring of all surface clearance and substantial excavations (>1 m deep) for fossil material (*e.g.* bones, teeth, fossil wood)	ECO / ESO	Construction	Yes	Inspect cleared ground and excavations for fossil remains. On-going, throughout construction phase
Surface clearance & substantial excavations (> 1 m deep)	Safeguarding of chance fossil finds (preferably *in situ*), followed by reporting of finds to SAHRA.	ECO / ESO	Construction	Yes	Define and secure fossil site with security tape. Report finds at earliest opportunity to SAHRA
Surface clearance & substantial excavations (> 1 m deep)	Recording and judicious sampling of significant chance fossil finds by a qualified palaeontologist, together with pertinent contextual data (stratigraphy, sedimentology, taphonomy).	Professional palaeontologist	Construction	Yes	Following consultation over chance fossil finds with SAHRA and professional palaeontologist
Surface clearance & substantial excavations (> 1 m deep)	Curation of fossil material within an approved repository (museum / university fossil collection). Submission of Phase 2	Professional palaeontologist	Construction	Yes	Following Phase 2 palaeontological mitigation

	palaeontological heritage report to HWC / SAHRA.				

7. CONCLUSIONS

In recent years the Middle Permian sedimentary bedrocks in the Klein-Roggeveldberge powerline study region (Abrahamskraal Formation, Lower Beaufort Group) have yielded scientifically-important fossils of petrified wood, tetrapod (terrestrial vertebrate) and lungfish burrows and trackways *plus* exceedingly rare skeletal remains of the *Tapinocephalus* Assemblage Zone, but well-preserved fossils are very sparsely distributed. The Abrahamskraal Formation bedrocks here are extensively covered by Late Caenozoic superficial sediments (*e.g.* scree, surface gravels, alluvium, gravelly soils) that are usually unfossiliferous. The overall palaeontological sensitivity of the study area is rated as low, although the potential for rare fossil sites of high palaeontological interest cannot be entirely discounted.

Most of the study area for the present WEF electrical infrastructure project has already been palaeontologically surveyed, *viz.* the Maralla West WEF, Maralla East WEF, Soetwater WEF and Karusa WEF project areas. The remainder has been covered by a supplementary 3-day site visit in October 2021.The great majority of the fossils recorded so far within the Maralla grid connection project area comprise widely-occurring forms (poorly-preserved fossil wood, sphenophyte ferns, lungfish burrows, low diversity invertebrate trace fossils) that are not considered to be of exceptional scientific or conservation value. None of the fossil sites recorded here lies within the footprints of the 132 kV powerline route options under consideration (see satellite map Appendix 1, Figures A1.1 & A1.2). Direct impacts on these known fossil sites are therefore not anticipated and no mitigation is recommended in regard to them.

The impact significance of the construction phase of the 132 kV powerline for the Maralla West and Maralla East WEFs is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources. This is a consequence of (1) the paucity of irreplaceable, unique or rare fossil remains within the project area as well as (2) the extensive superficial sediment cover overlying most potentially-fossiliferous bedrocks here. This assessment applies equally to the three 132 kV powerline corridors to Karusa Substation under consideration here. All the new powerline options to the Karusa Substation are likely to have a lower impact significance than the considerably longer approved connection to the Komsberg Substation. Impacts due to the construction of new access powerline access roads will probably be greater than those attributable to excavations for pylon footings. Significant further impacts during the operational and de-commissioning phases of the electrical infrastructure are not anticipated. There are therefore no preferences on palaeontological heritage grounds for any particular powerline route option among those under consideration. The no-go alternative (*i.e.* no development) will probably have a low (neutral) impact on palaeontological heritage.

Cumulative impacts on palaeontological heritage resources that are anticipated as a result of the numerous renewable energy developments currently proposed or authorised for the Klein-Roggeveldberge region, including the Maralla West and Maralla East WEFs and their electrical infrastructure, are anticipated to be MODERATE (NEGATIVE). Their significance would probably fall to LOW (NEGATIVE) *provided that* the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*cf* Almond 2016f). These anticipated levels of change are *acceptable*.

There are no fatal flaws in the Maralla WEF grid connection infrastructure development proposal as far as fossil heritage is concerned. *Provided that* the recommendations for palaeontological monitoring and mitigation outlined below (See also Section 6 of this report) are fully implemented, there are no objections on palaeontological heritage grounds to authorisation of the proposed 132 kV powerline. Pending the potential discovery of significant new fossil remains during construction, specialist palaeontological mitigation is not recommended for this project. The following general

recommendations concerning conservation and management of palaeontological heritage resources apply (See tabulated Chance Fossil Finds Protocol in Appendix 2).

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The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the Maralla WEF grid connection development should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads, pylon footings) and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO / ESO. Should significant fossil remains - such as vertebrate bones and teeth, or petrified logs of fossil wood - be encountered at surface or exposed during construction, the ECO / ESO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management agency as soon as possible - *i.e.* SAHRA (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). 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 developer's expense. These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Maralla WEF powerline project.

8. ACKNOWLEDGEMENTS

Ms Ashlea Strong of WSP | Parsons Brinckerhoff, Environment & Energy, Africa, Bryanston is thanked for commissioning this study, for providing the necessary background information, and for editorial input. I am, as always, especially grateful to Madelon Tusenius for companionship, for logistical assistance in the field, and - most of all - for finding fossils.

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10. SHORT CV OF AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and the University of Tübingen in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa and Madagascar. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA. Since 2002 Dr Almond has also carried out numerous palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest Province, Mpumalanga, Gauteng, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has served as a member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

APPENDIX 1: MARALLA WEF GRID CONNECTION ADDITIONAL FOSSIL SITE DATA: SEPTEMBER 2021

All GPS readings were taken in the field using a hand-held Garmin GPSmap 64s instrument. The datum used is WGS 84.

N.B. This palaeontological locality data supplements that provided in the PIAs report for the Maralla West, Maralla East, Soetwater and Karusa WEFs previously submitted by the author (See References). Fossil sites recorded in these earlier surveys as well as the recent 2021 site visit to the Maralla grid connection project area are plotted on a satellite image in Figure A1.Please note that:

- Locality data for South African fossil sites in *not* for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but only those sites recorded during the field survey. The absence of recorded fossil sites in any area therefore does *not* mean that no fossils are present there.
- The detailed stratigraphic data for each site is provisional and has yet to be confirmed.

Loc.	GPS data	Comments
497	32°48'20.02"S 20°37'16.46"E	De Hoop 202. Abrahamskraal Fm. Isolated blocks up to 9 cm across of poorly-preserved, silicified fossil wood (possibly partially decomposed before preservation) within surface gravels overlying major channel sandstone package. Proposed Field Rating IIIC. No mitigation recommended.
505	32°48'43.62"S 20°37'7.27"E	De Hoop 202. Abrahamskraal Fm. Basal channel sandstone and ferrugunised breccio-conglomerates containing rusty-brown moulds of plant debris, including woody axes and fragmentary leaves. Proposed Field Rating IIIC. No mitigation recommended.
520	32°43'36.08"S 20°41'30.08"E	Drie Roodeheuwels 180. Abrahamskraal Fm. Stream bed exposure of wave-rippled wacke bed top with effaced horizontal invertebrate burrows, probably *Scoyenia*. Proposed Field Rating IIIC. No mitigation recommended. Proposed Field Rating IIIC. No mitigation recommended.
522	32°43'37.58"S 20°41'24.93"E	Drie Roodeheuwels 180. Abrahamskraal Fm. Stream bed exposure of mottled, bioturbated grey and purple-brown wacke containing ill-defined subcylindrical invertebrate burrows. Purple-brown siltstone, wacke containing assemblage of round sandstone casts of reedy plant stems (probably sphenophyte ferns), *c*. 1 cm-wide. Proposed Field Rating IIIC. No mitigation recommended.
526	32°43'59.26"S 20°44'4.08"E	Drie Roodeheuwels 180. Abrahamskraal Fm. Brownish to grey-green wackes with veneer of purple-brown siltstone perforated by rounded to irregular casts of probable invertebrate burrows (and / or reedy plant stems). Proposed Field Rating IIIC. No mitigation recommended.
533	32°37'27.02"S 20°25'1.11"E	Orangefontein 203. Abrahamskraal Fm. Grey wackes with round sandstone casts of reedy plant stems (*c*. 1 cm diam.). Proposed Field Rating IIIC. No mitigation recommended.

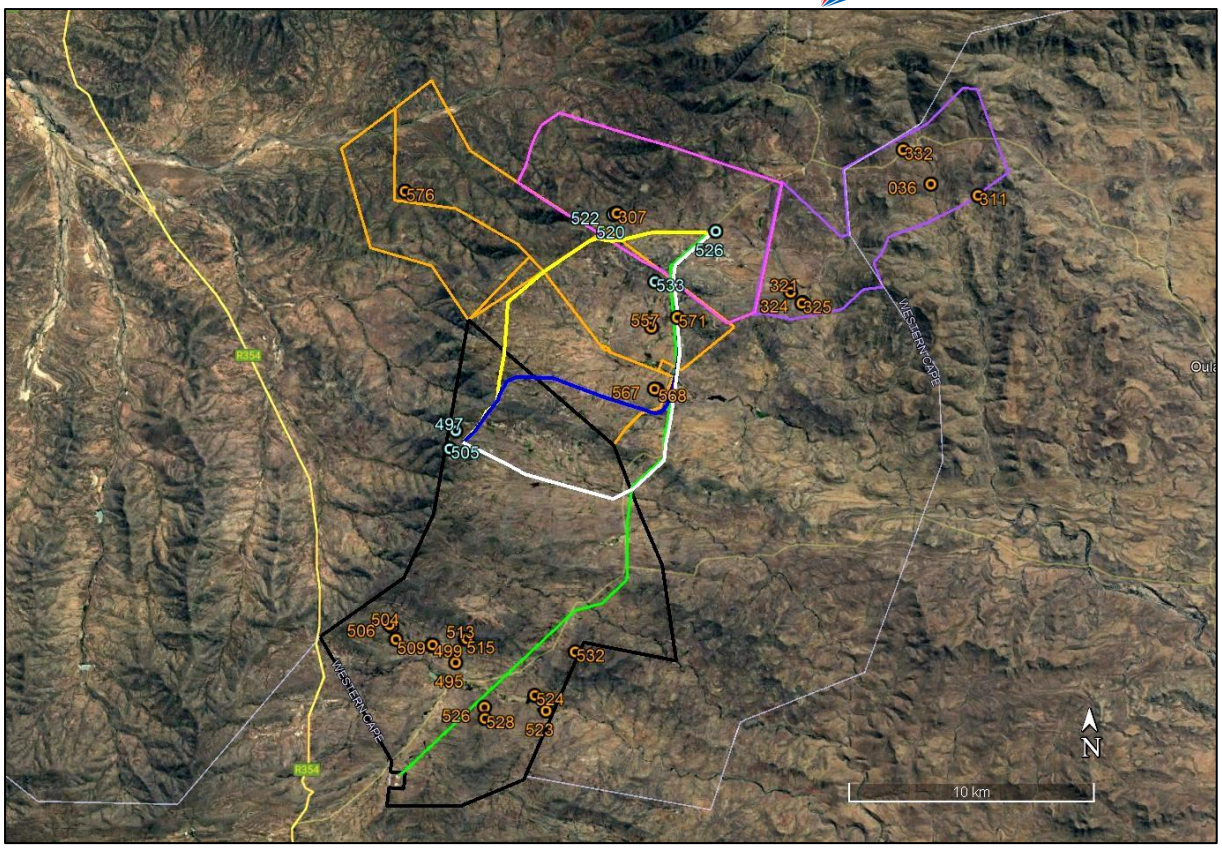

Figure A1.1: Google Earth© satellite image of the Maralla grid connection project area (See Figure 1 for the various WEF project areas and powerline route options). Fossil sites recorded during palaeontological site visits to the Karusa, Soetwater as well as Maralla West and Maralla East WEF project areas are indicated in orange (See relevant PIA reports for details). Additional fossil sites recorded during the recent 2021 site visit to the Maralla grid project area are indicated in blue (see table above for details). See following figure for more detail.

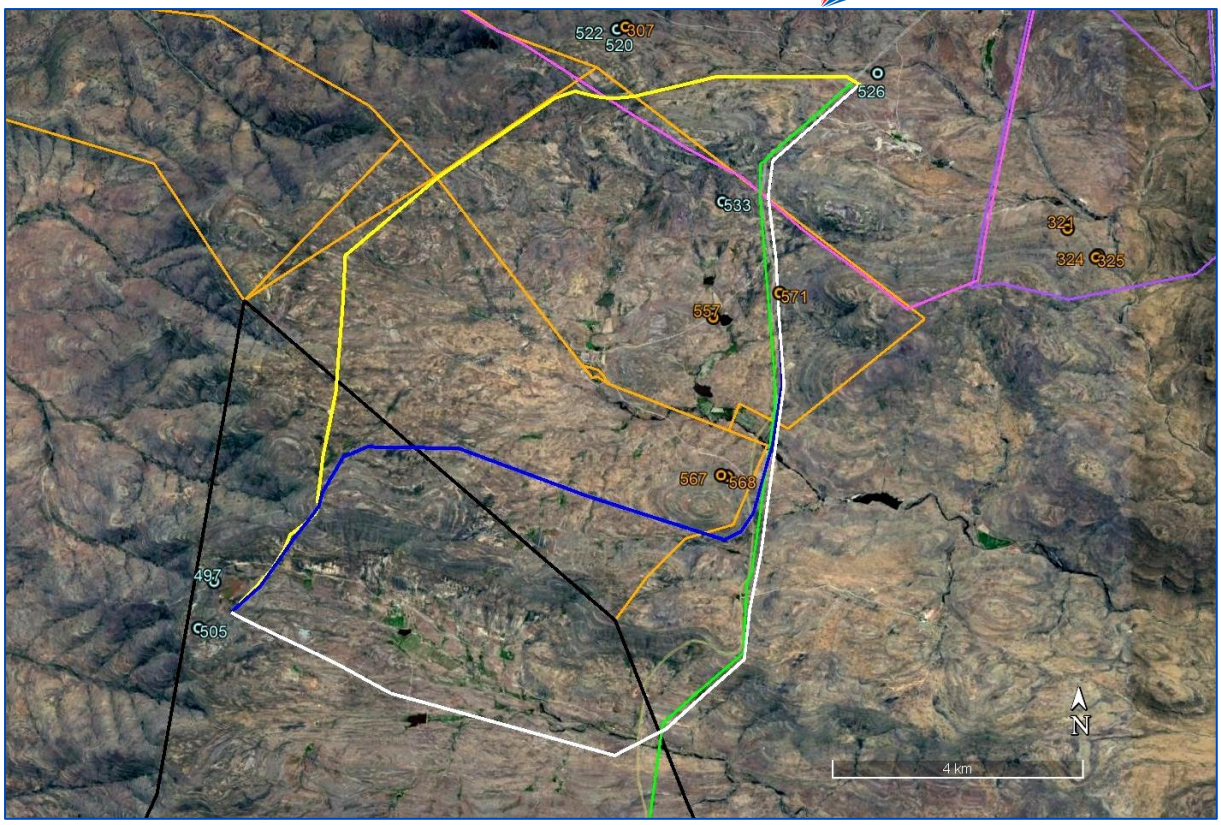

Figure A1.2: Close-up of the Maralla grid connection project area showing known fossil sites in the vicinity. None of the known fossil sites lies within the grid connection route options and therefore no mitigation is recommended with regard to these sites*. It is noted that the image does not record *all* potential fossil sites within the project area. Any additional sites which may be found or exposed during the construction phase of the development will be subject to a Chance Fossil Finds Protocol, as outlined in Appendix 2.

* Site 571 lies close to but *c*. 40 m east of the powerline Option 1A / 1B route and is therefore unlikely to be impacted by the powerline. It features downwasted fragments of petrified wood as well as ferruginised moulds of woody stems which have probably weathered-out from breccias within the base of thick channel sandstone body upslope and are of low scientific / conservation significance (Proposed Field Rating IIIC) (See Figs. 45 to 47 in Almond 2015d). Concentrations of LSA flaked artefacts also occur in the vicinity (chert, fine sandstone, vein quartz).

<table>
<tr><th colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROTOCOL: Maralla WEF grid connection to the Karusa WEF substation between Matjiesfontein and Sutherland</th></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape (Karoo Hoogland Local Municipality)</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">SAHRA for the Northern Cape (Contact details: South African Heritage Resources Agency. 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel : 021 462 4502).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation (Lower Beaufort Group, Karoo Supergroup), Late Caenozoic alluvium, colluvium, eluvium</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, large burrow casts (lungfish, tetrapods), trackways, petrified wood, plant-rich beds, invertebrate traces in the Abrahamskraal Fm bedrocks.
Fossil mammal bones, teeth, horncores, freshwater molluscs, plant material, calcretised termitaria in Late Caenozoic alluvium.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
• Context – describe position of fossils within stratigraphy (rock layering), depth below surface
• Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>

Table A3.1: Assessment of anticipated impacts on palaeontological heritage resources for the proposed Maralla WEF 132 kV grid connection to the Karusa WEF substation (construction phase). This assessment applies equally to all three powerline corridor options under consideration. Further significant impacts in the operational and de-commissioning phases are not anticipated.

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Palaeontological heritage	Disturbance, damage or destruction of fossils (direct, negative impacts) preserved at or beneath the ground surface within the development footprint , mainly due to surface clearance and excavation activities (e.g. access roads, pylon footings).	Construction	Negative	moderate	2	1	5	5	2	**26**	**N2**	2	1	5	5	2	**26**	**N2**
					Significance	**N2 - Low**							**N2 - Low**						

Table A3.2: Assessment of anticipated cumulative impacts on palaeontological heritage resources for the Maralla WEF 132 kV grid connection to the Karusa WEF substation in the context of numerous other WEF grid connection developments in the region (construction phase). This assessment applies equally to all three powerline corridor options under consideration. Further significant impacts in the operational and de-commissioning phases are not anticipated.

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Palaeontological heritage	Disturbance, damage or destruction of fossils (direct, negative impacts) preserved at or beneath the ground surface within the development footprint , mainly due to surface clearance and excavation activities.	Cumulative	Negative	Moderate	3	1	5	5	3	**42**	**N3**	2	1	5	5	2	**26**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						

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Date: 19 November 2021

Palaeontological Heritage Addendum

PROPOSED 132 kV TRANSMISSION INTEGRATION PROJECT FOR THE MARALLA WEST & MARALLA EAST WIND ENERGY FACILITIES NEAR SUTHERLAND, SUTHERLAND MAGISTERIAL DISTRICT, NORTHERN CAPE:

ADDITIONAL (4TH) GRID CORRIDOR OPTION

Three 132 kV grid line options from the authorised Maralla West and Maralla East WEFs (white, yellow and blue lines in Figure 1) have been assessed in the combined desktop and field-based PIA report by Almond (October 2021). The grid connection project area is underlain by sparsely fossiliferous continental sediments of the Permian age Lower Beaufort group (Karoo Supergroup).

A possible 4th option for the grid line (red line in Figure 1) has subsequently been proposed. This is broadly similar to the previously assessed Option 1B (blue line in Figure 1) but cuts across the Farm Oranjefontein more to the north where it can follow existing 132kV lines established by the Wind Energy Facility currently being built.

The proposed 4th grid corridor does not threaten any of the previously recorded fossil sites mapped in Figure 1 (Site 557, for example, is *c*. 100 m away from the proposed line). As for all three previously assessed grid line options, the impact significance of the construction phase of the new option is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources.

There are therefore no marked preferences on palaeontological heritage grounds for any particular powerline route option among the four options currently under consideration. It is noted, however, that the new (4th) grid option is likely to entail lower cumulative impacts on local palaeontological heritage resources since it would follow an existing powerline route. On these grounds, this 4th option is preferred from a palaeontological heritage perspective.

John E. Almond

Dr John E. Almond
Palaeontologist
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REFERENCES

ALMOND, J.E. 2021. Proposed 132 kV transmission integration project for the Maralla West & Maralla East Wind Energy Facilities near Sutherland, Sutherland Magisterial District, Northern Cape: palaeontological heritage basic assessment. Combined desktop and field-based report, 52 pp. Natura Viva cc, Cape Town.

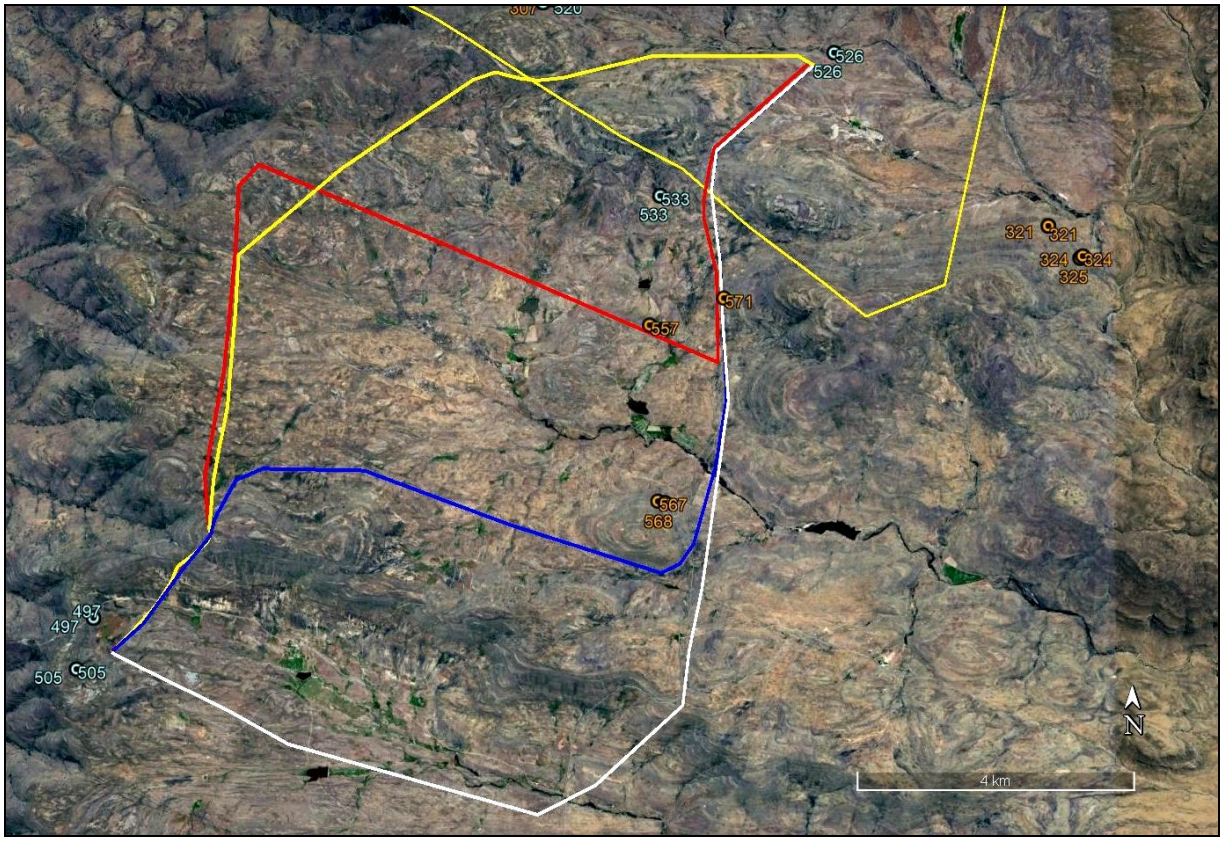

Figure 1: Google Earth© satellite image of the Maralla grid connection project area. Fossil sites recorded during palaeontological site visits to the Karusa, Soetwater as well as Maralla West and Maralla East WEF project areas are indicated in orange (See relevant PIA reports for details). Additional fossil sites recorded during the recent 2021 site visit to the Maralla grid project area are indicated in blue. None of the known fossil sites lies within the grid connection route options and therefore no mitigation is recommended with regard to these sites. It is noted that the image does not record *all* potential fossil sites within the project area. Any additional sites which may be found or exposed during the construction phase of the development will be subject to a Chance Fossil Finds Protocol, as outlined in Appendix 2 of the PIA report by Almond (2021).

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Palaeontological Impact Assessments & Heritage Management, Natural History Education, Tourism, Research

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Date: 7 May 2022

Palaeontological Heritage Addendum2

PROPOSED 132 kV TRANSMISSION INTEGRATION PROJECT FOR THE MARALLA WEST & MARALLA EAST WIND ENERGY FACILITIES NEAR SUTHERLAND, SUTHERLAND MAGISTERIAL DISTRICT, NORTHERN CAPE:

ADDITIONAL GRID CORRIDOR OPTIONS

Three 132 kV grid line options from the authorised Maralla West and Maralla East WEFs (white, yellow and blue lines in Figure 1) were assessed in the combined desktop and field-based PIA report by Almond (October 2021a). The grid connection project area is underlain by sparsely fossiliferous continental sediments of the Permian age Lower Beaufort Group (Karoo Supergroup).

A possible 4th option for the grid line (now known as Alt 3 - red line in Figure 1) was subsequently proposed and assessed at desktop level by Almond (2021b). Two additional grid line options have been proposed by Maralla landowners and are shown in Figure 1 as Alt 4(A) (green) and Alt 4(B) (orange).

None of the corridors under consideration directly threaten any of the previously recorded fossil sites mapped in Figure 1; none of the known fossil sites lies within 50m of the corridors. As for all four grid line options previously assessed by Almond (2021a, 2021b) , the impact significance of the construction phase of the two new ~~new~~ options is assessed as LOW (NEGATIVE) in terms of palaeontological heritage resources, given the generally LOW palaeo-sensitivity of the project area.

There are therefore no marked preferences on palaeontological heritage grounds for any particular powerline route option among the six options currently under consideration, as mapped in Figure 1. It was noted, however, by Almond (2021b) that the Alt 3 grid option is likely to entail lower cumulative impacts on local palaeontological heritage resources since it would follow an existing powerline route and on these grounds this option is (very marginally) preferred from a palaeontological heritage perspective.

John E. Almond

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REFERENCES

ALMOND, J.E. 2021a. Proposed 132 kV transmission integration project for the Maralla West & Maralla East Wind Energy Facilities near Sutherland, Sutherland Magisterial District, Northern Cape: palaeontological heritage basic assessment. Combined desktop and field-based report, 52 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2021b. Proposed 132 kV transmission integration project for the Maralla West & Maralla East Wind Energy Facilities near Sutherland, Sutherland Magisterial District, Northern Cape: additional (4th) grid corridor option. Palaeontological Heritage Addendum, 2 pp.

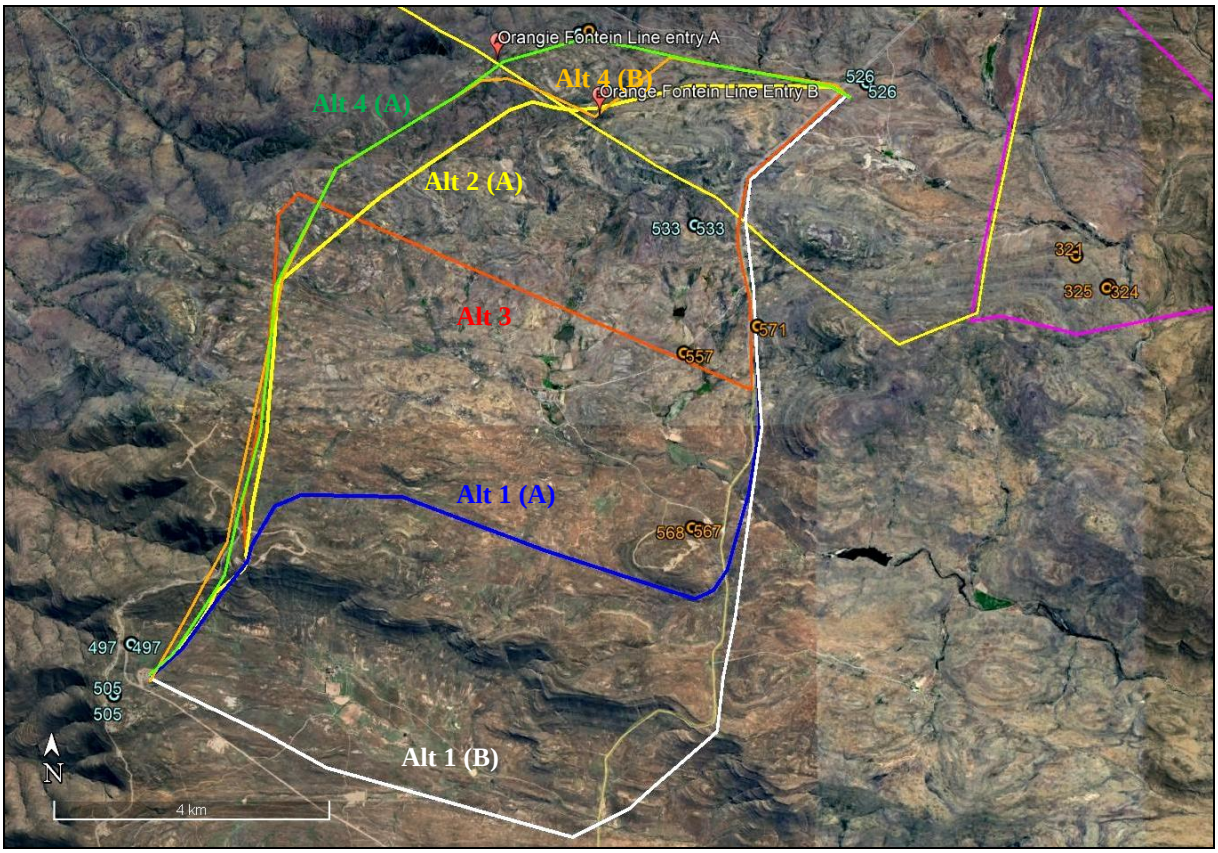

Figure 1: Google Earth© satellite image of the revised Maralla grid connection project area showing all six route options that are been considered. Fossil sites recorded during palaeontological site visits to the Karusa, Soetwater as well as Maralla West and Maralla East WEF project areas are indicated in orange (See relevant PIA reports for details). Additional fossil sites recorded during the 2021 site visit to the Maralla grid project area are indicated in pale blue.

The three grid connection options originally assessed by Almond (2021a) were Alt 1 (A) (dark blue), Alt 1(B) (white) and Alt 2(A) (yellow). A 4th Alternative – now termed Alt 3 (red) - was assessed by Almond (2021b). Two additional alignments proposed by Maralla landowners which are also covered in the present second Palaeontological Heritage Addendum are Alt 4(A) (green) and Alt 4(B) (orange).

None of the known fossil sites lies within the grid connection route options and therefore no mitigation is recommended with regard to these sites. It is noted that the image does not record *all* potential fossil sites within the project area. Any additional sites which may be found or exposed during the construction phase of the development will be subject to a Chance Fossil Finds Protocol, as outlined in Appendix 2 of the PIA report by Almond (2021a).

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