Palaeontological Heritage: Combined Desktop and Field-based Assessment

VICTORIA WEST RENEWABLE ENERGY CLUSTER, UBUNTU LOCAL MUNICIPALITY (PIXLEY KA SEME DISTRICT MUNICIPALITY), NORTHERN CAPE PROVINCE, RSA

John E. Almond PhD (Cantab.)
***Natura Viva* cc**
76 Breda Park, Breda Street,
Oranjezicht
CAPE TOWN 8001, RSA
naturaviva@universe.co.za

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EXECUTIVE SUMMARY

The company WKN-Windcurrent SA (Pty) Ltd. is proposing to develop, construct and operate a cluster of five Wind Energy Facilities (WEFs), each of up to 270MW generation capacity – *viz.* the Taaibos North, Taaibos South, Soutrivier North, Soutrivier Central and Soutrivier South WEFs - on an extensive site situated in the Upper Karoo region between the towns of Loxton and Victoria West in the Northern Cape Province. The combined project area of the proposed Victoria West Renewable Energy Cluster is situated in the Ubuntu Local Municipality (LM) which forms part of the Pixley ka Seme District Municipality (DM).

The palaeontological heritage of the region between Loxton and Victoria West is currently poorly known. On the basis of desktop studies as well as a 9-day palaeontological site visit to the combined renewable energy cluster project area the geological and hence palaeontological context of all the Victoria West Cluster WEF and SEF project areas is very similar. The following conclusions and recommendations therefore apply equally to each of the component renewable energy projects:

> The renewable energy project area is underlain by potentially fossiliferous continental (fluvial / lacustrine) sediments assigned to the Lower Beaufort Group (Abrahamskraal and Teekloof Formations) of Middle to Late Permian age. Provisional palaeosensitivity mapping by the DFFE Screening Tool suggests that the majority of the area is of Very High Sensitivity. However, desktop studies as well as a recent 9-day palaeontological site visit to the combined renewable energy cluster project area show that, in practice, fossil sites (rare tetrapod skeletal remains, trackways and burrows, invertebrate burrows, plant material) are very scarce here while the majority are of limited scientific and conservation value. The scarcity of fossils here is in large part due to the very poor levels of bedrock exposure - especially as regards potentially fossiliferous mudrock facies - as well as extensive regional thermal metamorphism of the Beaufort Group sediments by igneous intrusions. It is concluded that the palaeosensitivity of the project area is generally Low but with significant potential for unrecorded, largely unpredictable sites of high scientific and conservation value. The provisional palaeosensitivity mapping by the DFFE Screening Tool is accordingly *contested* in this report.
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> None of the known fossil sites of scientific or conservation value lies within or close to the footprint of the proposed renewable energy facility (see palaeontological site data and maps in Appendix 1). Furthermore, most of the recorded sites will be protected within standard ecological buffer zones along drainage lines and no mitigation is recommended in their regard. Given the potential for additional but unrecorded fossil sites of scientific value within the project area, a specialist palaeontological heritage walk-down of the authorized project footprint is recommended in the Pre-Construction Phase. The Chance Fossil Finds Protocol tabulated in Appendix 2 should be implemented during the Construction Phase. Recommended Mitigation and Management of palaeontological heritage for all athe Victoria West Cluster renewable energy projects is summarized in tabular form in Appendix 3.

Palaeontological heritage impacts due to the proposed renewable energy project are anticipated to be Low (Negative), both before and following mitigation (Table 1). A substantial and worthwhile reduction in impact significance is expected where previously unrecorded fossil sites of high scientific value are identified and mitigated in the Pre-Construction or Construction Phase. This analysis applies to the Construction Phase; significant further impacts during the Operational and De-commissioning Phases are not anticipated.

Anticipated cumulative impacts on local palaeontological heritage due to the various Victoria West WEF and SEF projects in the context of existing or proposed renewable energy projects between Loxton and Victoria West are anticipated to be Low (Negative) and to fall within acceptable limits. This assessment is based largely on the paucity of significant fossil sites recorded hitherto within the combined cluster project area and assumes that the proposed Pre-Construction and Construction Phase mitigation measures recommended for all these projects are implemented in full.

The proposed renewable energy project is not fatally flawed and there are no objections in terms of palaeontological heritage to its receiving environmental authorization. The recommended palaeontological heritage mitigation outlined below as well as summarized in the Chance Fossil Finds Protocol appended to this report (Appendix 2) should be included within the EMPr for the development.

- **Palaeontological heritage input into the EMPR**

Despite the scarcity of recorded fossil sites in the region, the potential for further, unrecorded palaeontological sites of high scientific and conservation value within the renewable energy project area cannot be excluded. These sites are best identified and mitigated through (1) a specialist palaeontological heritage walk-down of the authorized WEF and SEF footprints in the Pre-Construction Phase and (2) the application of a Chance Fossil Finds Protocol by the ECO / ESO during the Construction Phase (See Appendix 2) which should be incorporated into the EMPrs for the development. The qualified palaeontologist responsible for mitigation work will need to apply for a Fossil Collection Permit for the Northern Cape from SAHRA. Fossil material collected must be curated, together with pertinent collection data, within an approved repository (*e.g.* museum or university collection). Minimum standards for PIA reports have been compiled by Heritage Western Cape (2021) and SAHRA (2013). Recommended Mitigation and Management Measures regarding palaeontological heritage within the Victoria West Cluster project areas are summarized in tabular form in Appendix 3.

1. Project outline and brief

The company WKN-Windcurrent SA (Pty) Ltd. is proposing to develop, construct and operate a cluster of five Wind Energy Facilities (WEFs), each of up to 270MW generation capacity – *viz.* the Taaibos North, Taaibos South, Soutrivier North, Soutrivier Central and Soutrivier South WEFs - on an extensive site situated in the Upper Karoo region between the towns of Loxton and Victoria West in the Northern Cape Province (Figures 1, 14 & 15. The combined project area of the proposed Victoria West Renewable Energy Cluster is situated in the Ubuntu Local Municipality (LM) which forms part of the Pixley ka Seme District Municipality (DM). Technical details and maps for each WEF and SEF are provided in Appendix 5.

CES - Environmental and Social Advisory Services, Gqeberha / Port Elizabeth has been appointed by the developer as the Environmental Assessment Practitioner (EAP) to conduct the necessary EIA Processes for the Victoria West Renewable Energy Cluster projects that are required in terms of the National Environmental Management Act (NEMA, Act No. 107 of 1998 and subsequent amendments) EIA Regulations (2014 and subsequent 2017 amendments). The Victoria West Renewable Energy Cluster will be connected to the National Grid at Gamma MTS Substation near Hutchinson *via* a 400kV overhead line (OHL) which will is subject to a separate Basic Assessment processes.

The combined project area for the renewable energy cluster overlies potentially fossiliferous sedimentary bedrocks of the Lower Beaufort Group (Karoo Supergroup) that are provisionally rated as being of High to Very High Palaeosensitivity (DFFE Screening tool, SAHRIS palaeosensitivity map). Following the requirements of the National Heritage Resources Act (Act No. 25 of 1999), the present combined desktop and field-based palaeontological heritage report for the Victoria West Cluster WEF and SEF projects has been commissioned by CES - Environmental and Social Advisory Services, Gqeberha / Port Elizabeth (Contact details: Ms Caroline Evans. CES - Environmental and Social Advisory Services. Tel.: +27 (0)87 549 0239. Head Office Tel.: +27 (0)46 622 2364. E-mail: c.evans@cesnet.co.za) as part of the separate, broad-based Heritage Impact Assessments and Environmental Management Programmes (EMPrs) for each of the component renewable energy projects. The Provincial Heritage Resources Agency responsible for heritage resource management – including palaeontology - in the Northern Cape is the South African Heritage Resources Agency, Cape Town (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za).

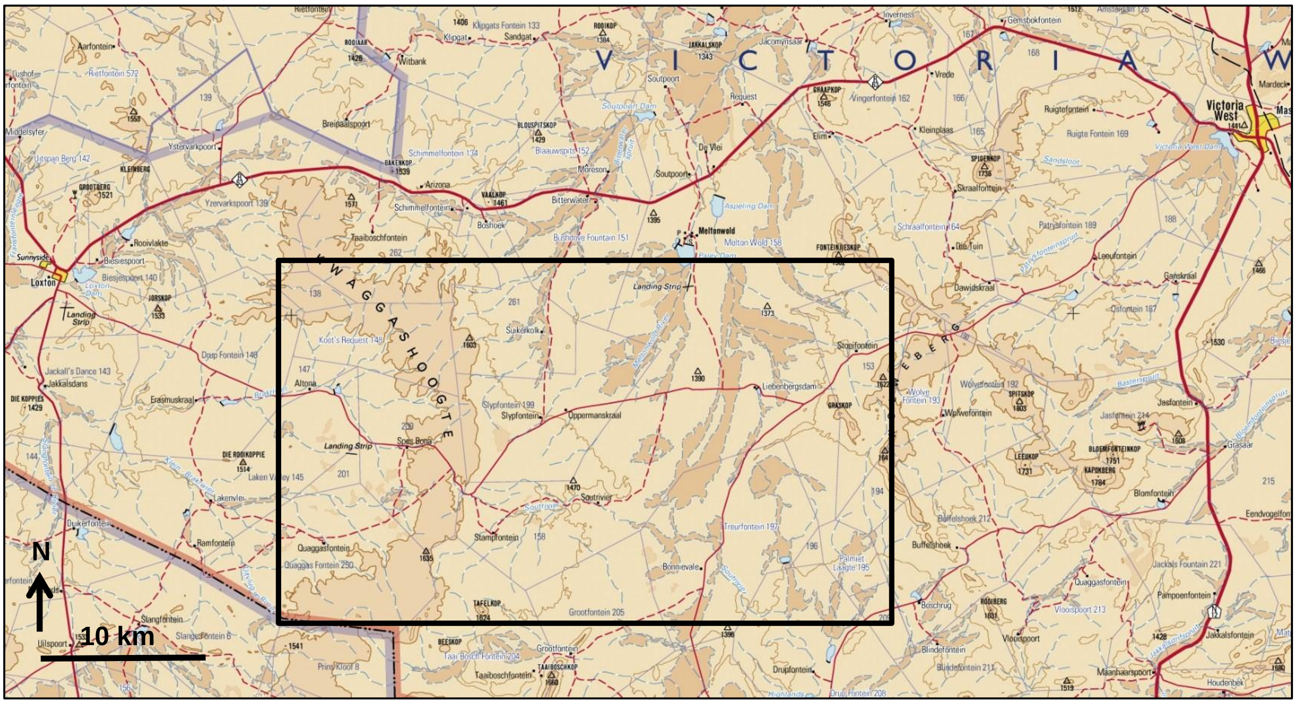


Figure 1: Extract from 1: 250 000 topographical sheet 3122 Victoria West (courtesy of Chief Directorate; Surveys and Mapping, Mowbray) showing the *approximate* location of the proposed Victoria West Renewable Energy Cluster combined project area between Loxton and Victoria West, Northern Cape Province (black rectangle).

2. Terms of Reference

The Scope of Work for the palaeontological specialist studies includes the following tasks:

• Undertake a site inspection to identify the site sensitivities, and verify them in terms of the National Web-Based Screening Tool (https://screening.environment.gov.za/).

• Determination, description and mapping of the baseline environmental conditions (geology / palaeontology) and palaeosensitivity of the study areas in question. Specify development setbacks / buffers, and provide clear reasons for these recommendations. This environmental screening will inform each project layout.

• Conduct field surveys and compile specialist studies in adherence to: (a) the gazetted Environmental Assessment Protocols of the NEMA EIA Regulations (2014, as amended), where applicable (*i.e.* Part A - General Protocol for the Site Sensitivity Verification and Minimum Report Content Requirements where a Specialist Assessment is required but no specific Environmental Theme Protocol has been prescribed (GG 43110 / GNR 320, 20 March 2020)); (b) Appendix 6 of the NEMA EIA Regulations (2014, as amended) (GG 40772 / GNR 326, 07 April 2017); (c) National Heritage Resources Act (Act No. 25 of 1999), as applicable; and (d) any additional relevant legislation and guidelines that may be deemed necessary

• Provide sensitive features spatial data in a useable GIS format (kmz / shp);

• Assess the direct, indirect and cumulative impacts associated with the proposed renewable energy and grid connection developments, with and without mitigation;

• Address relevant concerns / comments raised by Interested and Affected Parties and Stakeholders, including the Competent Authority, during Public Participation Processes on the respective Draft Scoping and EIA Reports and BA Reports;

• Identify relevant permits that may be required;

• Recommend mitigation measures, best practice management actions, monitoring requirements, and rehabilitation guidelines for all identified impacts to be included in the respective Environmental Management Programmes (EMPr);

• Update draft specialist assessment reports after Environmental Assessment Practitioner (EAP) and Client review (before public release) and following public review for submission to the Competent Authority for decision-making; and

• Address any queries from the Competent Authority during the decision-making phase (as and when they arise).

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 developed by SAHRA (2013).

3. Study approach and information sources

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations, members *etc.*) represented within the study area are determined from geological maps and satellite images.

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

New fossil sites encountered during the field-based survey are recorded and mapped on satellite images using GPS (Appendix 1). The focus of palaeontological field assessment is *not* simply to survey the development footprint or even the development area as a whole (*e.g.* farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more representative exposures of all the sedimentary rock units present (*N.B.* Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (*e.g.* formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Consolidated as well as uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the field study where they are well-represented in the study area.

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

3.1. Information sources

The combined desktop and field-based palaeontological heritage studies of the Victoria West Cluster and associated Grid Connection projects is based on the following information resources:

1. Short, tabulated project outlines, kmz files, screening reports, draft scoping reports and maps provided by CES;

2. A desktop review of:

(a) the relevant 1:50 000 scale topographic maps (3122BC Schimmelfontein, 3122CB Slangfontein, 3122DA Slypfontein and 3122DB Wolweberg) & as well as the 1:250 000 scale topographic map 3122 Victoria West;

(b) Google Earth© satellite imagery;

(c) published geological and palaeontological literature, including the 1:250 000 geological map (3122 Victoria West, Council for Geoscience, Pretoria) and the relevant sheet explanations (Le Roux & Keyser 1988);

(d) recent palaeontological heritage assessments (PIAs) for WEFs and solar energy facilities in the Upper Karoo region between Beaufort West, Loxton and Victoria West by the author (*e.g.* Almond 2015a, 2020a-d, 2021, 2022a-e) and colleagues.

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

4. An approximately nine-day reconnaissance-level palaeontological field assessment (2 to 8 September, 23 to 25 September, 2022) of the combined project area (six days with two heritage specialists, 3 days with one specialist), including portions of almost all land parcels involved (access to some parcels was not available during the field study, *e.g.* Slypfontein 2/199). Since it is impossible to palaeontologically survey the entire huge project area in detail, a focussed palaeontological heritage "walkdown" of selected, potentially sensitive sectors of the authorised project footprints with judicious mitigation of potentially threatened, scientifically valuable fossil sites in the Pre-construction Phase is recommended here.

Since the combined Victoria West Cluster forms a geologically and palaeontologically coherent unit, a consolidated geological and palaeontological study of the entire WEF and SEF project area *plus* separate assessments (with generic impact assessment table), conclusions and recommendations for each component renewable energy project (WEF / solar facility / grid connection) is submitted here.

3. Legislative context

All palaeontological heritage resources in the Republic of South Africa are protected by the National Heritage Resources Act (Act 25 of 1999). The body responsible for heritage resource management in the Northern Cape is the South African Heritage Resources Agency, SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za).

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (Act 25 of 1999) 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 agency.
(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 agency, or to the nearest local agency offices or museum, which must immediately notify such heritage resources Agency.
(4) No person may, without a permit issued by the responsible heritage resources agency—
(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 agency 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 agency 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 recently been published by SAHRA (2013) and Heritage Western Cape (2021).

4. Assumptions and limitations

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

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

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

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

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

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

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

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

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

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

Given the very extensive combined project area of the Victoria West Cluster, only a small fraction of the total area could be studied during the 9-day site visit which is therefore only a reconnaissance-level survey. Very little time was spent, for example, within the 300m powerline corridor connecting the Taaibos and Soutrivier collector substation. Some sectors of the combined Victoria West cluster project area could not be accessed in the time available while access to land parcel Slypfontein 2/199 was not granted during the two site visits. It is noted that this land parcel will receive a high proportion of the proposed infrastructure for the Soutrivier North WEF. Fieldwork in the Loxton – Victoria West area in September was partially constrained by heavy rains, river flooding and locally by very muddy roads while visibility for palaeontological recording was limited by poor exposure of potentially fossiliferous mudrock facies due to colluvium, alluvium, soils and pervasive grassy / karroid *bossieveld* vegetation. Confidence levels for the observations and conclusions reached in this report are therefore rated as Medium.

Most of the constraints experienced would apply throughout the year, so the season during which fieldwork took place did not have a substantial impact on the conclusions reached here.

5. Geological context of the project area

The combined Victoria West Renewable Energy Cluster project area between Loxton and Victoria West is situated in semi-arid, rocky to hilly terrain of the Upper Karoo region at elevations between *c*. 1200 and 1500 m amsl. (Figures 2 to 13, 15). The combined project area falls within the Ubuntu Local Municipality (Pixley Ka Seme District Municipality) of the Northern Cape, RSA. The area is bordered and transected by low ranges of rubbly, dolerite-capped ridges and hills, such as the north-south trending Kwaggashoogte Ridge (1635 m amsl) which runs largely between the two WEF project areas and the Wolweberg Range (1641 m amsl) to the east. Intervening, extensive, gravelly to sandy plains and low benches capped by Beaufort Group channel sandstones are drained towards the west by the Brakrivier and Klein-Brakrivier (Taaibos WEF project area) and towards the southeast by the Soutrivier and its tributaries and to the northeast by the Bitterwaterspruit and Meltonwold River (Soutrivier WEF project areas). A high proportion of the Beaufort Group sedimentary bedrocks in the region have been thermally metamorphosed by a dense network of dolerite sills and dykes. Apart from thicker channel sandstone bodies, sedimentary bedrock exposure is generally poor – especially as regards the potentially fossiliferous, recessive weathering mudrock facies (Satellite imagery paints a rather “optimistic” picture of bedrock exposure, as shown by ground truthing during the site visit). The latter are mainly seen along drainage lines and occasional borrow pits, with small patches of exposure along low, sandstone-capped escarpments and in gullied areas in the *vlaktes*. Most of the Victoria West cluster project area is mantled by thick, sandy to gravelly colluvial and alluvial deposits as well as surface gravels and karroid *bossieveld* vegetation dominated by grasses and dwarf shrubs.

The geology of the Victoria West Cluster project area is outlined on 1: 250 000 geological sheet 3122 Victoria West (Council for Geoscience, Pretoria) (Figure 14) with a short accompanying explanation by Le Roux & Keyser (1988). The area is largely underlain at depth by continental (fluvial / lacustrine) sediments of the Lower Beaufort Group (Karoo Supergroup) of late Middle to early Late Permian age (~ late Capitanian – Early / Middle Wuchiapingian, *c*. 260 to 256 Ma = million years ago). The sedimentary succession represented here is assigned to the uppermost part of the **Abrahamskraal Formation** and the lower part of the **Teekloof Formation** (**Poortjie and Hoedemaker Members**) and spans the environmentally critical boundary between the Middle and Late Permian Periods (Figure 53). The detailed lithostratigraphy and mapping of the Lower Beaufort Group succession in this sector of the Main Karoo Basin - including the correlation of the main channel sandstone packages such as the Poortjie Member - remains unresolved (*cf* Day & Rubidge 2020a, Almond 2022b, 2022c, 2022d). For the purposes of the present report, the mapping shown on the 1: 250 000 geological sheet is provisionally accepted, though this may well require revision in future. Levels of tectonic deformation in the study region are generally low, and most beds are flat-lying to gently dipping except where displaced by dolerite intrusion. Fault lines are often picked out on satellite images by dark rows of woody shrubs.

Figure 2: View southwards into the wide valley of the Soutrivier and its tributaries on Farm 1/197. The uplands in the foreground on RE/197 are built of baked Poortjie Member sandstones.

Figure 3: Extensive gravelly *vlaktes* on Farm RE/197 with surface gravels dominated by pale baked quartzite and dolerite clasts, looking towards the flat mountain Perdeberg to the SW which lies well outside the project area.

Figure 4: Streambed exposures of baked Poortjie Member mudrocks and channel sandstones within dissected uplands east of Suikerkolk farmstead on Farm 261, overlain by a rusty-brown dolerite sill seen on the skyline.

Figure 5: The N-S trending Kwaggashoogte ridge running between the Taaibos and Soutrivier WEF project areas, viewed from the southeast. The ridge forms the edge of a large, saucer-shaped dolerite sill.

Figure 6: Small, rubbly *koppies* of Karoo dolerite, part of a major ring-shaped intrusion, project above sandy to gravelly plains underlain by baked Poortjie Member sediments on Farm 4/145.

Figure 7: Die Rooikoppie on the western margins of the Taaibos WEF project area on Farm 4/145, viewed from the west, with orange-hued sandy to gravelly soils in the foreground.

Figure 8: Doleritic uplands of the Dwarsberg range on the SE margins of the Taaibos WEF project area with low benches of baked Poortjie Member channel sandstone in the middle ground, viewed from Farm 2/200.

Figure 9: Doleritic terrain forming the northern extension of the Kwaggashoogte Ridge, seen here on the NE margins of the Taaibos WEF project area on Farm RE/148.

Figure 10: Shallow river bed underlain by baked Poortjie Member channel sandstone and locally blanketed by coarse, angular quartzite gravels, view towards the east on Farm RE/148.

Figure 11: Low relief, grassy terrain underlain by the Poortjie Member on Farm 1/200, showing minimal bedrock exposure.

Figure 12: View towards the north on Farm RE/250 showing low benches and scarps capped by tabular Poortjie Member channel sandstones.

Figure 13: Gravelly *vlaktes* on Farm 2/212 to the SE of the Soutrivier South project area with low benches of baked Poortjie Member sandstones along the foot of the Wolweberg in the distance.

The **Abrahamskraal Formation** (Pa, pale green in geological map Figure 14) is currently mapped in the north-western sector of the combined Soutrivier WEF project area as well as on the western margins of the Taaibos WEF project area. In the former case relief is generally low and mudrock exposures are very limited, mainly occurring along the margins of low, sandstone-capped benches. Good mudrock exposures were not observed in the latter area, which may have been incorrectly mapped, while the bedrocks here are extensively baked by dolerite intrusions. The precise stratigraphic member(s) represented in these two areas have not been determined. In the Loxton area equivalents of the mudrock-rich Karelskraal Member at the top of the Abrahamskraal Formation succession may be missing so that the basal Teekloof Formation sits directly on the sandstone-dominated Moordenaars Member (Le Roux & Keyser 1988, p.6). Mudrocks within the Abrahamskraal Formation outcrop area are predominantly, but not exclusively, pale grey-green.

The great majority of the Victoria West Cluster project area is mapped within the outcrop area of the **Poortjie Member** (Ptp, dark green with stipple in Figure 14). A thick package of yellow-brown channel sandstone bodies observed in the Slypfontein – Erasmuskraal – Lakenvlei area (in and around the southern portion of the Taaibos WEF project area) is *provisionally* equated here to the lower part of the Poortjie Member; alternatively, this may incorporate elements of the Moordenaars Member sandstone package (as appears to be the case from the 1: 250 000 map). The overlying, thinner, well-spaced yellowish or purple-brown sandstone packages with intervening thick purple-brown and grey-green mudrock intervals are provisionally assigned here to the upper Poortjie Member. The mudrock-dominated **Hoedemaker Member** is only mapped in a small sector along the south-eastern margins of the Taaibos WEF project area (Pth, dark green without stipple in Figure 14). The bedrocks here are riddled with dolerite intrusions (*e.g.* Dwarsberg) and therefore unlikely to yield conservation-worth fossil remains (*cf* Almond 2022d). These limited Hoedemaker Member outcrops will not receive significant WEF infrastructure, were not examined during the site visits, and will therefore not be treated further here

The diachronous contact between the Poortjie and Hoedemaker Members in the Loxton area is transitional over an interval some 25-30 m. It is marked by the Reiersvlei Meanderbelt package identified by Smith (1987, 2021) and is of considerable palaeontological as well as palaeoenvironmental interest. The precise level of the contact is arbitrary to an extent and has been variously interpreted in maps and recent scientific literature. On the 1: 250 000 geological map of the Victoria West Cluster study area (Figure 14) the entire Reiersvlei Meander Belt seems to have been incorporated within the upper Poortjie Member. Given these lithostratigraphic ambiguities, the stratigraphic position of the geological and fossil sites mentioned in this report provisionally follows that shown on the published 1: 250 000 geological map.

The Poortjie – Hoedemaker Member transition zone is characterised by a succession of thin, single-storey, yellow-brown or purple-brown / -grey hued channel sandstones and intervening, predominantly reddish-brown mudrocks (Smith & Keyser 1995, Paiva 2015, Maharaj et al. 2019, Smith *et al.* 2021). This stratigraphic interval records the transition from thick, multi-storey channel sandstones dominated by downstream accretion processes typical of the Poortjie Member to laterally accreting, meandering river systems of the Hoedemaker Member. The transition is accompanied by more frequent development of crevasse splay deposits and calcareous palaeosols on the floodplain driven by increased aridification in the Karoo Basin and aggradation of the Reiersvlei Meanderbelt sedimentary prism (Maharaj *et al.* 2019, Smith *et al.* 2021). In contrast, a subsidence-driven transition is favoured by Paiva (2015). Sandstone-capped benches and scarps, with very limited, patchy exposure of dusky grey-green and purple-brown overbank mudrocks characterise much of the upper Poortjie Member outcrop area. The Poortjie channel sandstones locally show well-developed large-scale cross-bedding (~N-directed palaeocurrents) and gullied bases with lenticular basal breccias rich in mudflake intraclasts as well as reworked pedogenic calcrete glaebules. Evidence of Late Caenozoic karstification (solution weathering) is seen, for example, in the Soutrivier South project area. Mudrocks contain abundant pedocrete horizons as well as rusty-brown lenses of diagenetic ferruginous carbonate. Wave-and current-rippled palaeosurfaces (playa lakes, channel ponds) are associated with microbial mat textures (MISS) and locally with large tetrapod trackways (Section 6).

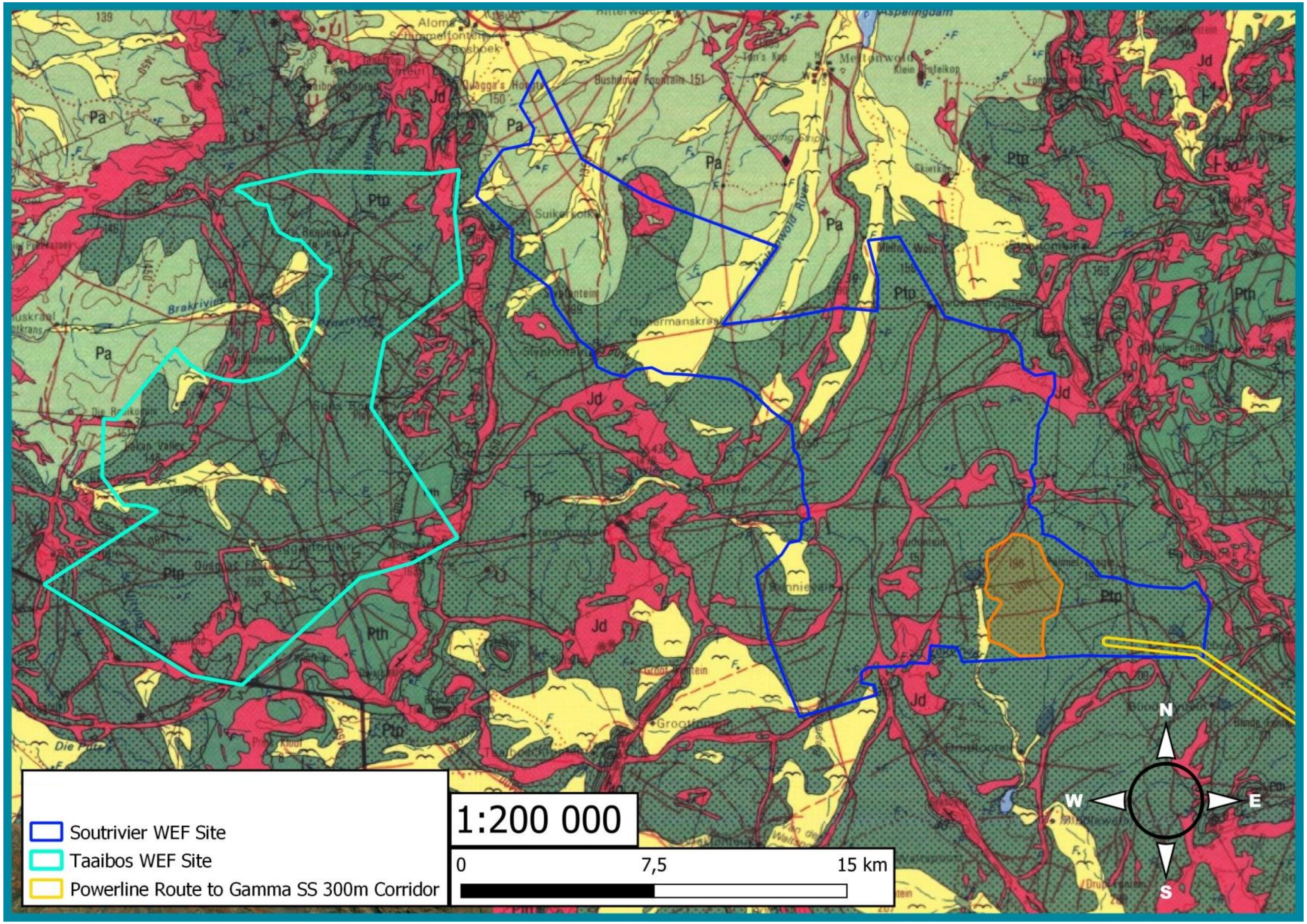
In this sector of the Upper Karoo the Beaufort Group sediments are intruded by an extensive network of dyke and sill complexes of the Early Jurassic **Karoo Dolerite Suite** (*e.g.* Kwaggashoogte, Wolweberg). At least some of these bodies probably correspond to shallow, saucer-shaped sills with upturned, ring-like margins such as those described by Chevallier and Woodford (1999). This would explain the thermal metamorphism of a high proportion of the sedimentary country rocks in the study region which is in turn responsible for the generation of large volumes of block, colluvial and alluvial gravels of metaquartzite and hornfels. Together with sandy to gravelly alluvial deposits in low relief areas, these resistant-weathering gravels now obscure most of the Beaufort Group mudrock facies.

Kimberlite pipes and other intrusions are known in the wider Victoria West – Loxton area, for example at Melton Wold and Droogfontein (170-140 Ma maximum age, *cf* Le Roux & Keyser 1988) but none are mapped within the present study area on the published 1: 125 000 geology sheet. The Melton Wold kimberlite pipe is indicated by the small black diamond symbol on map Figure 14.

The Permian and Jurassic bedrocks within the Victoria West Cluster project area are extensively mantled by a range of **Late Caenozoic superficial deposits**, limiting exposure levels of fresh (unweathered), potentially fossiliferous Permian sediments of the Lower Beaufort Group. In addition to thick sandy to gravelly alluvial sediments mapped along major active or defunct drainage lines (*e.g.* Soutrivier, Brakrivier and their tributaries), these younger cover sediments include pan deposits, colluvial deposits (blocky sandstone / quartzite / hornfels scree, finer-grained hillwash) and eluvial (downwasted) surface gravels, pedocretes (*e.g.* calcrete hardpans), spring and pan deposits (*e.g. brak kolle*) and a spectrum of mainly sandy to gravelly soils. Well-consolidated, calcretised colluvial prisms typical of the Pleistocene Masotcheni Formation in the Eastern Cape, Free State and KZN were not recognised, but their equivalents may well occur here as well. Elevated terraces of calcretised, rubbly older fluvial gravels are locally associated with common, crudely-flaked Early Stone Age and younger artefacts (*e.g.* along the Soutrivier) and are probably of Pleistocene age.

Illustrated illustrations of representative rock exposures within the combined Victoria West Cluster project area are given below in Figures 16 to 51, together with explanatory figure legends.

Figure 14: (following page): Extract from 1: 250 000 geology sheet 3122 Victoria West showing the outlines of the proposed Victoria West Cluster renewable energy project areas between Loxton and Victoria West, Northern Cape (Base map published by the Council for Geoscience, Pretoria. Image kindly prepared by CES). The main rock units represented here include:
Pa (pale green) = Middle Permian Abrahamskraal Formation.
Ptp (middle green with stipple) = Middle Permian Poortjie Member, Teekloof Formation (Adelaide Subgroup).
Pth (middle green without stipple) = Late Permian Hoedemaker Member, Teekloof Formation (Adelaide Subgroup).
Jd (red) = sills and dykes of the Early Jurassic Karoo Dolerite Suite.
Pale yellow with flying bird symbol = Late Caenozoic (Neogene / Pleistocene to Recent) alluvium. *N.B.* The mapping of the various members within the Teekloof Formation shown here is contested.


Soutrivier WEF Site
Taaibos WEF Site
Powerline Route to Gamma SS 300m Corridor
1:200 000
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7,5
15 km
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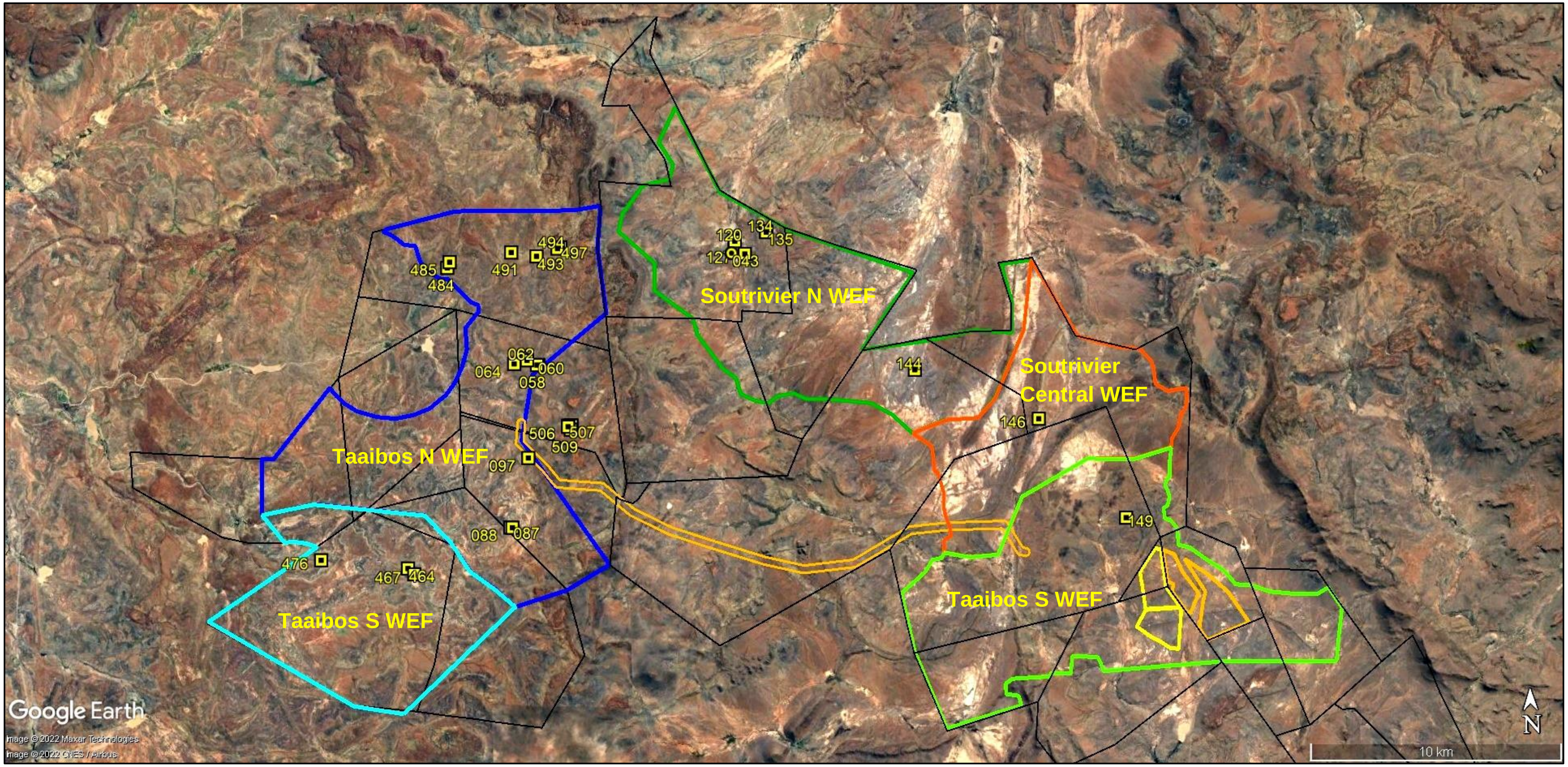

Figure 15: Google Earth© satellite image of the combined Victoria West Cluster project areas between Loxton and Victoria West, Northern Cape Province. Loxton lies approximately 15 km to the west. Rusty-brown areas are Early Jurassic dolerite intrusions while pale areas indicate thick Late Caenozoic alluvial sediments. This subregion of the Bo-Karoo is characterised by large, shallow, saucer-shaped dolerite sills, such as the one enclosing most of the Taaibos WEF project areas (*e.g.* Kwaggashoogte Range), which have baked a large proportion of the overlying Permian Beaufort Group continental sediments, seriously compromising their palaeosensitivity. Only ~ 30 new fossil sites (numbered yellow squares) were recorded within and close to the renewable energy project areas during the two recent palaeontological site visits (See Appendix 1 for more detailed fossil site maps in relation to proposed infrastructure layouts of the component renewable energy facilities).

Figure 16: View westwards towards the dolerite-capped Kwaggashoogte Ridge showing a low scarp of Abrahamskraal Formation channel sandstones and overbank mudrocks along the edge of the Bitterwaterspruit, just north of Suikerkolk farmstead, Farm 261. The mudrocks here have yielded fragmentary skeletal remains of large tetrapods (*cf* Figures 55 & 56).

Figure 17: Low scarp exposure of purple-brown and grey-green overbank mudrocks capped by channel sandstones of the upper Abrahamskraal Formation on Farm 261.

Figure 18: Lens of rusty-brown ferruginous carbonate (*koffieklip*) of diagenetic origin within overbank mudrocks of the Abrahamskraal Formation, Farm 261.

Figure 19: Prominent channel sandstone *kranz* just north of the homestead on Farm 1/145 Lakenvlei (*c.* 1 km west of and outside the Taaibos WEF project area) that is provisionally interpreted here as the sandstone-dominated lower part of the Poortjie Member. However, the 1: 250 000 geological map indicates this may be the Moordenaaars Member sandstone package forming the uppermost part of the Abrahamskraal Formation near Loxton.

Figure 20: Poortjie Member channel sandstones and overbank mudrocks on Farm 4/145, just west and outside the Taaibos WEF project area.

Figure 21: Purplish-brown hued channel sandstone package and overbank mudrocks within the upper part of the Poortjie Member on Farm 1/250. The lithostratigraphic and biostratigraphic placement of these beds is currently equivocal.

Figure 22: Tabular, thin- to medium-bedded channel sandstone body of the upper Poortjie Member on Farm 3/158.

Figure 23: River bed and bank exposure of baked Poortjie Member grey-green, overbank sediments on Farm RE/148.

Figure 24: Gullied hillslope exposures of upper Poortjie Member mudrocks on Farm RE/250, just north of Quaggasfontein homestead. This locality has yielded a large chunk of the long bone of a large-bodied tetrapod (*cf* Figure 58).

Figure 25: Small area of Poortjie Member purple-brown mudrocks on Farm RE/250. Such patchy exposures are sparsely scattered throughout the WEF project areas and are a primary target for vertebrate fossil recording.

Figure 26: Poortjie Member mudrock exposure in deeply gullied terrain within the Soutrivier project area on Farm RE/195. On the whole, mudrock facies are very poorly exposed within the low-relief project areas.

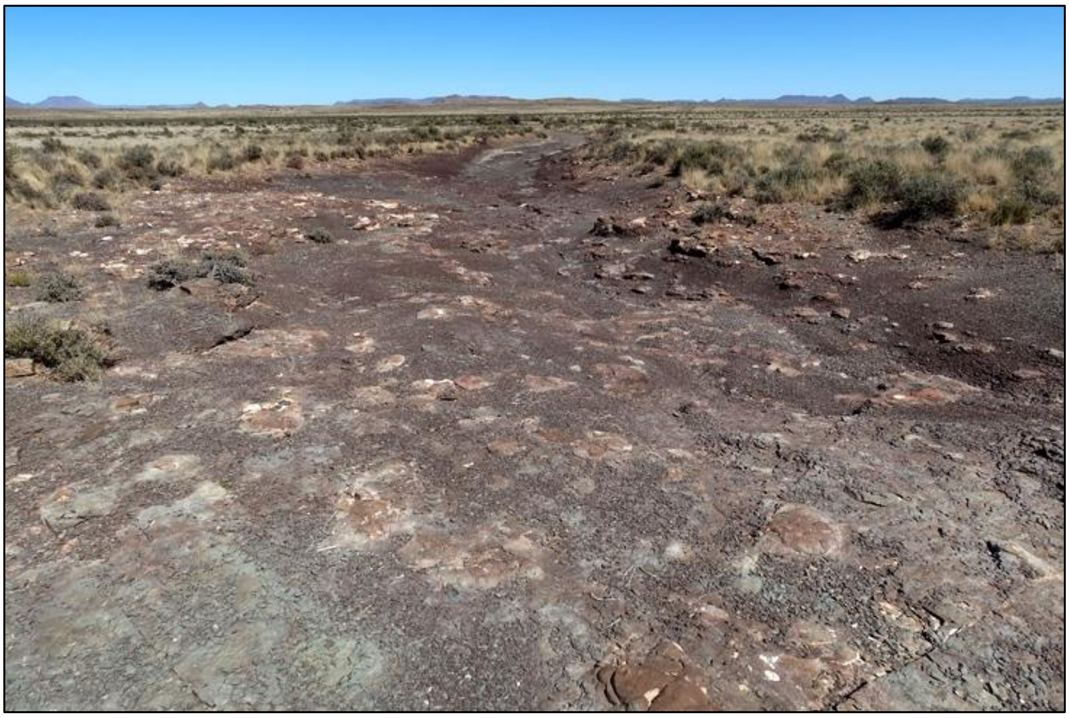

Figure 27: Streambed exposure of hackly-weathering Poortjie Member mudrocks with abundant rusty-brown, ferruginous carbonate and pedocrete concretions at some horizons, seen here on Farm 2/212 in the SE corner of the combined Soutrivier WEF project area.

Figure 28: Small patches of purple-brown Poortjie Member mudrocks exposed on Farm RE/201.

Figure 29: Thick lens of rusty-brown diagenetic *koffieklip* within the Poortjie Member, stream bed exposure on Farm 2/200 (hammer = 30 cm).

Figure 30: Eluvial (downwasted) surface gravels dominated by dark brown, ferruginous pedocrete concretions from the Poortjie Member on Farm RE/250. Such areas are a focus for recording vertebrate fossils which are often associated with such palaeosol horizons.

Figure 31: Good riverbank cliff section through purple-brown overbank mudrocks and overlying tabular-bedded, heterolithic channel bank / levee facies on Farm RE/148 (hammer = 30 cm). The pale hues of the pedocrete horizon (below hammer) show that the sediments have been strongly baked.

Figure 32: Polygonal desiccation cracks within Poortjie Member grey-green mudrocks picked out by pale, more resistant-weathering calcrete veins, Farm 1/200 (hammer = 30 cm).

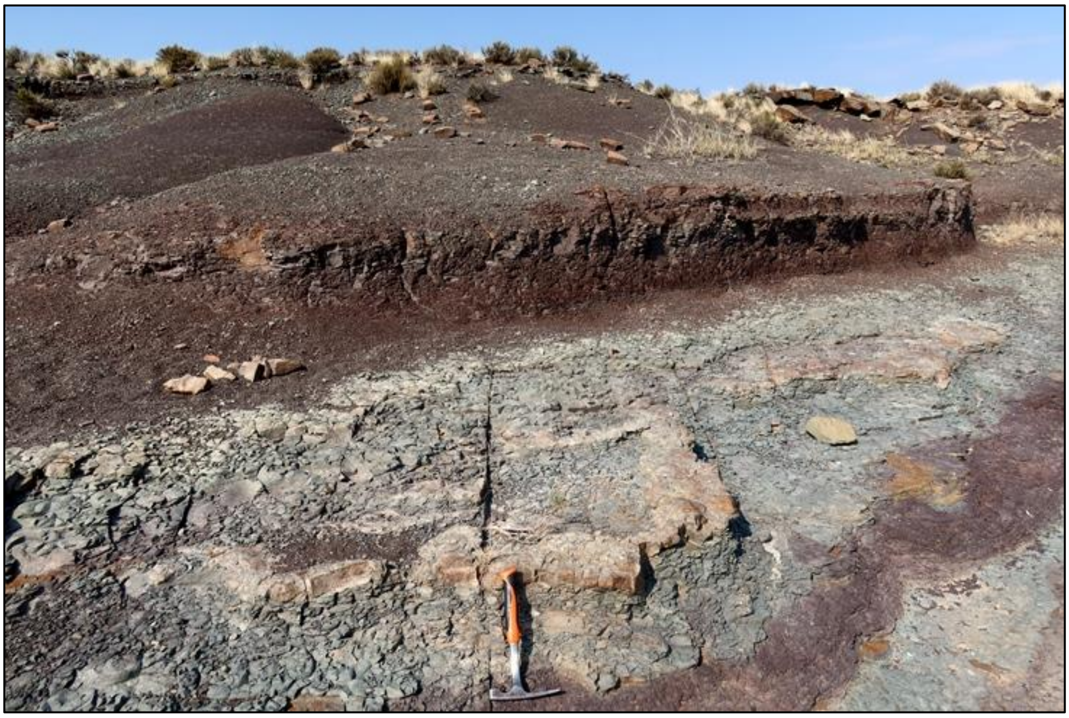

Figure 33: Streambank exposures of Poortjie Member grey-green and purple-brown mudrocks with a well-developed ferruginous calcrete palaeosol horizon, *c*. 500m west of Spes Bona farmstead on Farm 3/200 (hammer = 30 cm).

Figure 34: Unusually thick riverbank section through tabular-bedded, heterolithic levee and channel sandstone facies of the Poortjie Member on Farm RE/148.

Figure 35: Blocky-weathering of well-jointed, baked channel and crevasse-splay wackes of the Poortjie Member on Farm RE/148. Angular gravels derived from baked wackes dominate local alluvial and colluvial deposits.

Figure 36: Close-up of surface gravels dominated by angular, brownish quartzite clasts and greyish pedocrete concretions in an outcrop area of baked Poortjie Member bedrocks on Farm RE/148 (hammer = 30 cm).

Figure 37: Borrow pit cut face on Farm RE/197 showing finely laminated to thin-bedded dark mudrocks, mapped within the Poortjie Member – possibly a distal alluvial plain or playa lake facies (hammer = 30 cm).

Figure 38: Cliff of resistant-weathering, baked Poortjie Member mudrocks and fine-grained wackes facing westwards onto the Soutrivier Valley, Farm RE/197 (hammer = 30 cm).

Figure 39: Extensive streambed exposures of baked Poortjie Member wackes on Farm RE/148. Such sections are always worth searching for tetrapod trackways, such as those illustrated in Section 6.

Figure 40: Narrow subvertical dyke of Karoo dolerite intruding Poortjie Member mudrocks showing clear cooled and baked margins, riverbank section near Spes Bona farmstead on Farm 3/200 (hammer = 30 cm).

Figure 41: Thick, well-jointed dolerite dyke within the Poortjie Member outcrop area on Farm RE/148.

Farm 42: Well-developed, pale calcrete hardpan exposed by recent sheet floods in road near Oppermanskraal homestead, Farm 2/199 (hammer = 30 cm).

Figure 43: Coarse modern alluvial gravels and older, slightly elevated "High Level Gravels" along the Soutrivier on Farm RE/197. The older gravels are associated with common ESA flaked artefacts of Pleistocene age (inset, scale = 15 cm).

Figure 44: Thick, intensely gullied, semi-consolidated colluvial deposits mantling a valley floor on Farm 1/145. These deposits might be equivalent to the Pleistocene Masotcheni Formation of the Free State and KZN but are uncalcretised and probably younger.

Figure 45: Close-up of the semi-consolidated, gravelly to sandy colluvial deposits illustrated above (hammer = 30 cm).

Figure 46: Stream gulley exposing purple-brown and grey-green Poortjie Member bedrocks beneath a pervasive blanket of gravelly to sandy superficial deposits, Farm 2/200.

Figure 47: Thick sandy to gravelly alluvial deposits exposed in a stream bank on Farm RE/148.

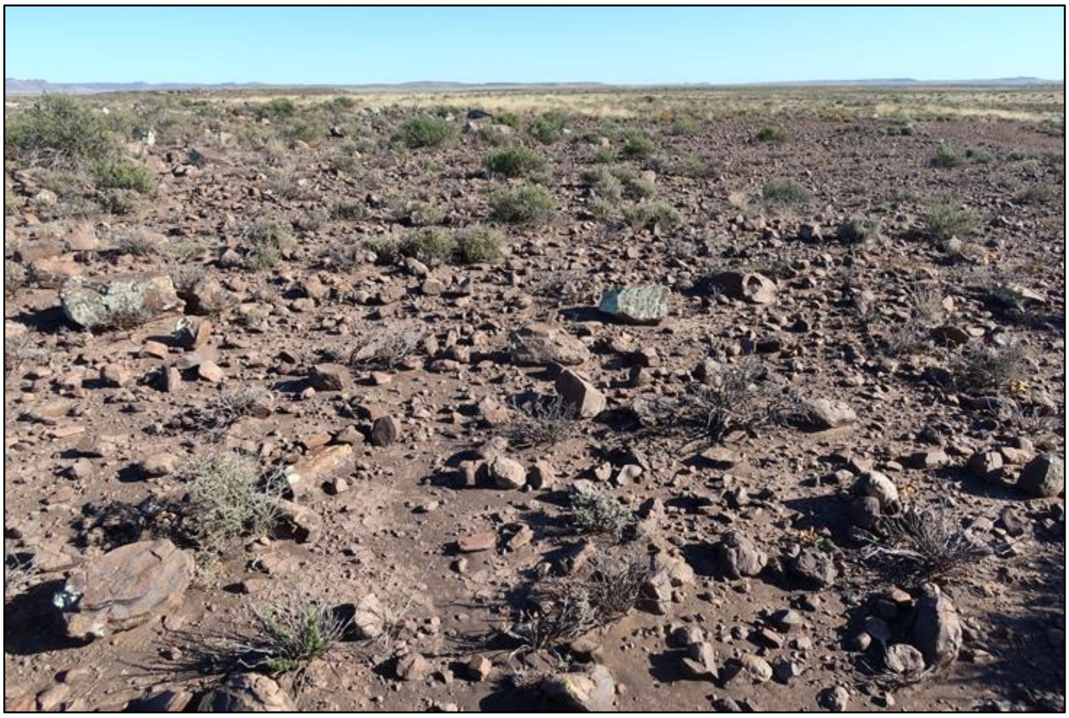

Figure 48: Downwasted eluvial gravels dominated by purple-brown wacke clasts derived from the upper Poortjie Member, Farm 3/158.

Figure 49: Gravelly *vlaktes* just southwest of the Soutrivier South project area with a veneer of brownish pedocrete concretion clasts, Farm 3/208.

Figure 50: Flat, sandy to gravelly terrain within the Soutrivier South project area on Farm RE/195 with the dolerite-capped Wolweberg Range to the northeast.

Figure 51: Open, unvegetated pan-like areas or *brak kolle* carpeted with fine silty sediment and surface gravels, open *vlaktes* within the Soutrivier South project area on Farm RE/195.

6. Palaeontological context of the project area

The Middle to Late Permian Abrahamskraal and Teekloof Formation bedrocks in the combined Victoria West Cluster project area are characterised by fossil assemblages within the upper part of the ***Tapinocephalus* Assemblage Zone** and the lower part of the succeeding ***Endothiodon* Assemblage Zones** (the latter was previously termed the *Pristerognathus* and *Tropidostoma* Assemblage Zones (Kitching 1977, Keyser & Smith 1977-78, Rubidge 1995, Rubidge 2005, Van der Walt *et al.* 2010, Smith *et al.* 2012, Smith *et al.* 2020, Day & Rubidge 2020b, Day & Smith 2020) (Figures 52 & 53). They include a wide range of fossil tetrapods - especially true reptiles such as pareiasaurs and therapsids ("mammal-like reptiles" or protomammals"") - as well as fish, temnospondyl amphibians, plant remains (*e.g.* petrified wood, plant compressions), microfossils and trace fossils (*e.g.* vertebrate and invertebrate burrows, tetrapod trackways and burrows). These fossil assemblages and the sedimentary bedrocks within which they occur are of special scientific interest because they span the environmentally critical boundary between the Middle and Late Permian Periods which was associated with the catastrophic Late Capitanian Mass Extinction Event of *c*. 260 Ma (million years ago) (Day *et al.* 2015). Capitanian to Wuchiapingian fossil biotas within the Lower Beaufort Group in the NW sector of the Main Karoo Basin between Loxton and Victoria West have been discussed in several recent PIA reports by the author (See Almond 2022a-d in References).

Only a few historical vertebrate fossil sites are mapped near Loxton on the published 1: 250 000 geological map and in the key early review by Kitching (1977) but no sites are marked within the present project area on the published 1: 250 000 geological map (Figure 14). The Karoo fossil vertebrate site map of Nicolas (2007) shows low density of fossil records east of Loxton with just a few sites recorded south and north of the town (Figure 54). The region between Loxton and Victoria West is the subject of ongoing palaeontological research by Professor Bruce Rubidge of the Evolutionary Studies Institute (ESI), Wits University as well as Dr Mike Day of the Natural History Museum, London. Important concentrations of fossil sites are known to the north of the Victoria Cluster WEF project area near Melton Wold guest farm (*e.g.* collections by R. Smith and colleagues of Iziko Museums, Cape Town) and west of Gamma Substation as a result of a long history of palaeontological fieldwork in the Biesiespoort area (close to the eastern sector of the associated Grid Connection Corridor) (Day & Rubidge 2020a). The Melton Wold fossils (some specimens of which displayed in town museums in Victoria West and Fraserburg) come from the upper Abrahamskraal beds and include representatives of the large-bodied Pareiasauria (including an articulated skull and skeleton of a bradysaurid) and Dinocephalia (see isolated brown diamond symbol on the geological map) as well as gorgonopsians, small dicynodonts, coprolites and palaeoniscoid fish.

Recent palaeontological fieldwork by the present author for WEF, SEF and grid connection project areas in the broader Loxton – Victoria West – Beaufort West region (*e.g.* Nuweveld WEFs, Hoogland WEFs, Modderfontein WEF, Victoria West WEF Cluster, Mura Solar project areas, Skietkuil / iLanga project areas – see References under Almond) and earlier research by other Karoo palaeontologists (*e.g.* Smith 1993) suggest that unrecorded fossil sites of scientific and conservation value are likely to occur here. However, vertebrate fossil records are often sparse in areas that have been intensively intruded and baked by dolerite. New tetrapod fossil finds within the project area should help resolve outstanding lithostratigraphic / biostratigraphic ambiguities in the region as well as contributing to on-going scientific research concerning palaeoenvironmental and evolutionary events before and during the catastrophic end-Middle Permian Extinction Event of *c*. 260 million years ago as well as during the succeeding biotic recovery (Retallack *et al.* 2006, Day *et al.* 2015).

Most of the varied Late Caenozoic superficial sediments within the project area are of low palaeosensitivity. However, relict and often consolidated older (Neogene / Pleistocene) alluvial deposits along drainage lines might contain sporadic fossil assemblages of mammals (bones, teeth, horn cores), freshwater invertebrates (*e.g.* unionid bivalves) and trace fossils (*e.g.* calcretised termitaria, rhizoliths / plant root casts).

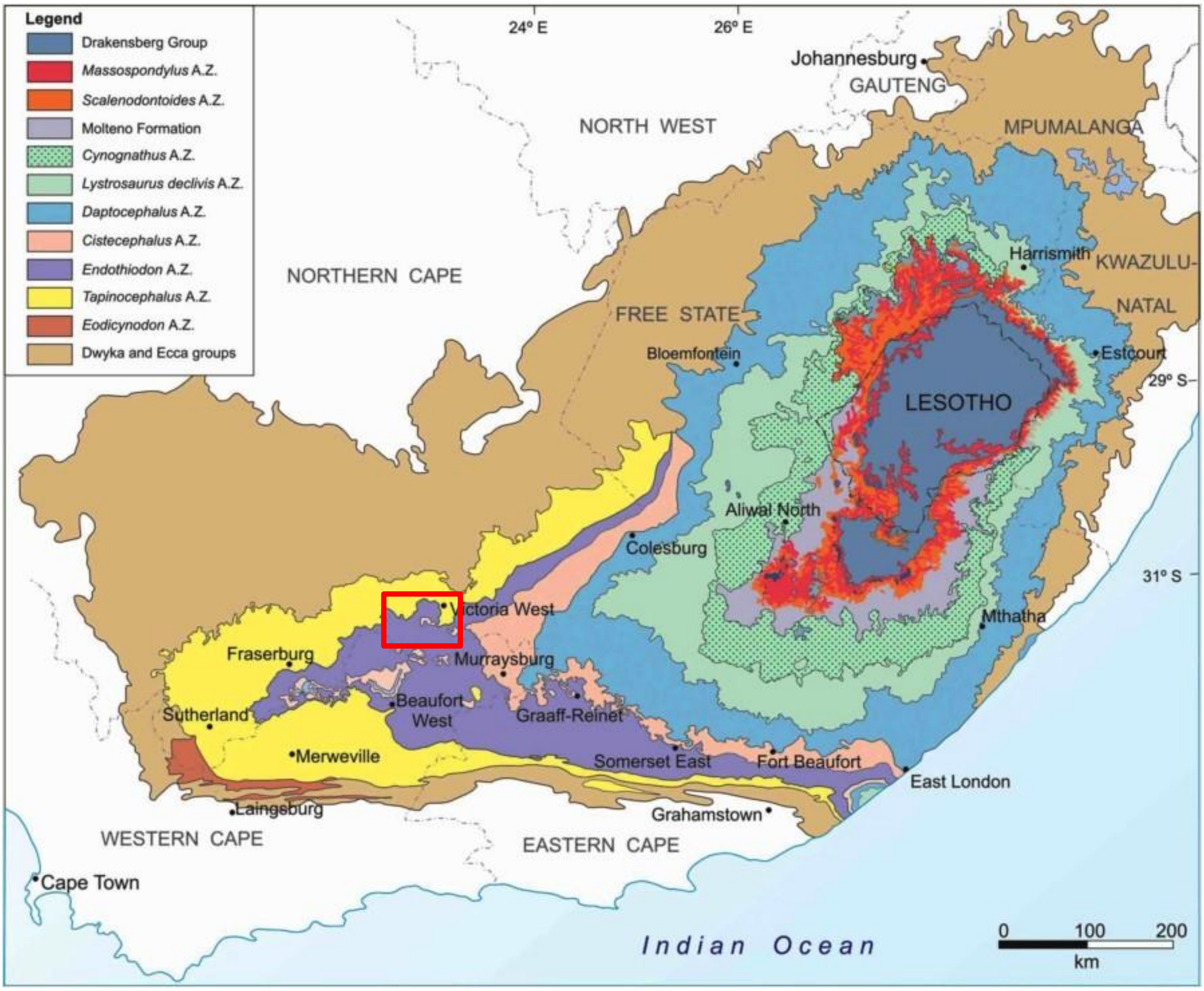

Figure 52: The latest fossil biozonation map for the Main Karoo Basin (Smith *et al.* 2020) shows the occurrence of late Middle to early Late Permian fossil assemblages of the *Tapinocephalus* Assemblage Zone and the succeeding *Endothiodon* Assemblage Zone in the Victoria West Cluster project area in the north-western sector of the Main Karoo Basin between Loxton and Victoria West (small red rectangle).

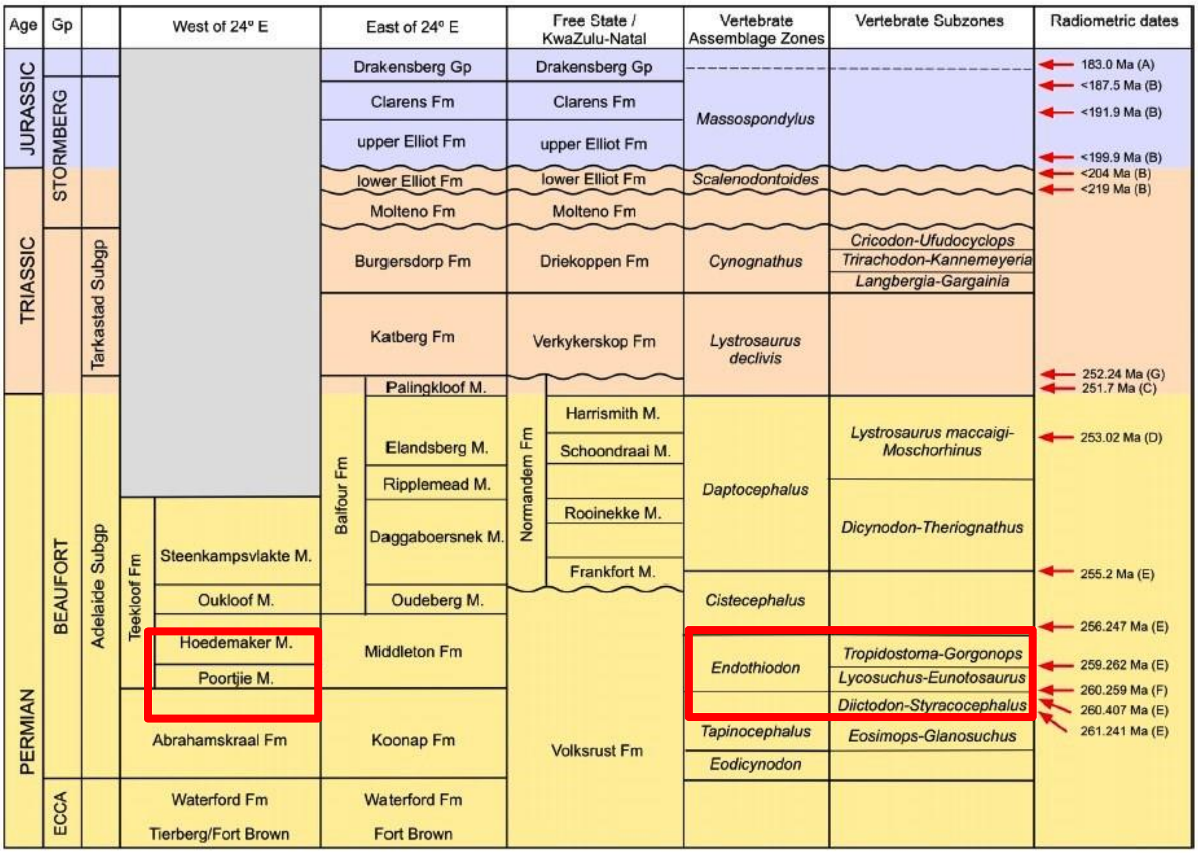

Figure 53: Chart showing the latest, revised fossil biozonation of the Lower Beaufort Group of the Main Karoo Basin (abstracted from Smith *et al.* 2020). Rock units and fossil assemblage zones mapped within the combined Victoria West Cluster and associated Grid Connection project area are outlined in red respectively. The detailed mapping of these lithostratigraphic and biostratigraphic units within the present project area within the north-western sector of the Main Karoo Basin is unresolved at present. The Hoedemaker Member bedrocks in the present project area have very small outcrop areas that are intensively intruded by dolerite and therefore unlikely to yield many fossils of scientific or conservation value.

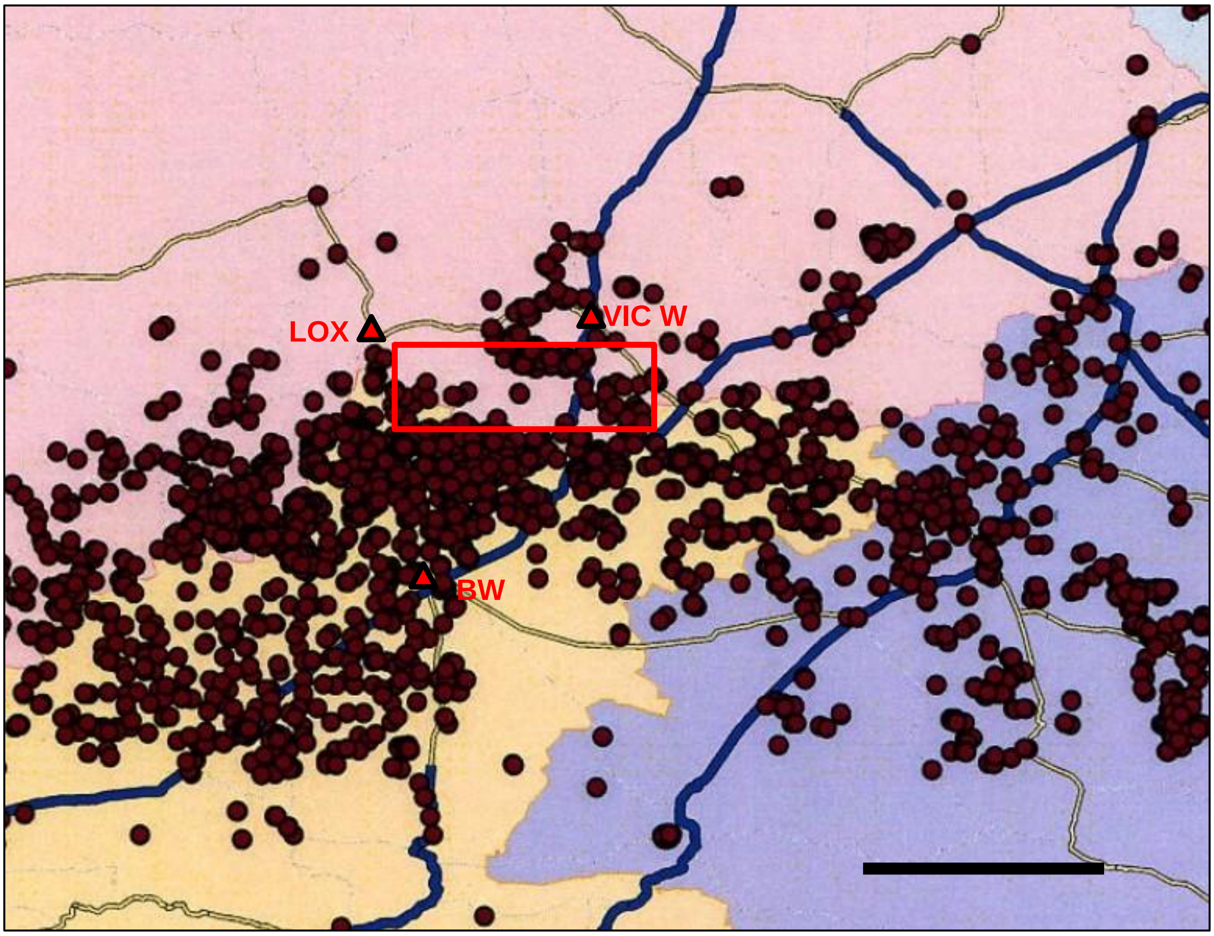

Figure 54: Distribution map of recorded vertebrate fossil sites within the Lower Beaufort Group of the Great Karoo between Loxton (LOX), Victoria West (VIC W) and Beaufort West (BW), showing the very *approximate* outline of the study area for the Victoria West Cluster and associated grid connection within the red rectangle (map abstracted from Nicolas 2007). There are currently almost no recorded fossil sites from the WEF project areas. Fossil sites in the north-central area reflect in part collection around Melton Wold guest farm. The abundance of known fossil sites close to the N1 to the northeast of Three Sisters and south of Victoria West reflects in part the long history (> 100 years) of fossil collection by both academics as well as knowledgeable amateurs at sites close to Biesiespoort Station. Scale bar = 10 km. N towards the top of the image.

6.1. Palaeontological heritage recorded during the site visit

Only a very sparse scatter of new palaeontological heritage sites was recorded during the recent nine-day site visit to the combined Victoria West Cluster project area (Figure 15). The small number of fossil sites is probably largely a consequence of the generally low levels of exposure of potentially fossiliferous mudrocks in the region. High intensive of dolerite intrusion (including shallow saucer-shaped sills) is also a major factor. This has compromised fossil preservation within metamorphosed country rocks and generated large volumes of resistant-weathering colluvial and eluvial gravels which blanket the potentially fossiliferous bedrocks. Furthermore, silicified skeletal material is less likely to be naturally prepared-out from the host sediments by weathering since the latter have also been highly consolidated through heating and hydrothermal processes following dolerite intrusion.

A representative sample of the new fossil remains are illustrated in Figures 55 to 85 below. GPS locality details as well as a short description, Proposed Field Rating and any recommended mitigation measures are tabulated in Appendix 1, where the fossil sites are also mapped on satellite images in the context of provisional infrastructure layouts (See also satellite map Figure 15 for an overview).

The **Abrahamskraal Formation** in the northern sector of the Soutrivier WEF project area has yielded several *ex situ* chunks of postcranial bone from large-bodied tetrapods (Figures 55 to 57). Since large-bodied dicynodonts are not known from the Main Karoo Basin this early on, they are probably either dinocephalian therapsids or pareiasaur reptiles; both of these tetrapod subgroups have been recorded from similar aged beds in the Melton Wold area just north of the Victoria West Cluster project area.

Very few skeletal remains of tetrapods have been recorded so far from poorly-exposed mudrock facies within the very extensive **Poortjie Member** outcrop area. The handful of small tetrapods – mainly remains of small dicynodonts such as *Diictodon* – are mostly baked and disarticulated, with the exception of one poorly-preserved articulated specimen (Figures 77 to 80). The only body fossil of a large-bodied tetrapod is a partial robust limb bone recorded from surface float on the upper Poortjie Member on Farm RE250 Quaggas Fontein (Figure 58); the Poortjie / Hoedemaker Member contact is mapped shortly to the southeast of the site. This specimen is of scientific interest since neither dinocephalians nor pareiasaurs are unequivocally recorded from the lower portion of the *Endothiodon* Assemblage Zone (*Lycosuchus-Eunotosaurus* Subzone) currently recognised in the upper Poortjie Member (Day & Smith 2020, Day & Rubidge 2021). However, probable cranial fragments of a tapinocephalid dinocephalian have recently been reported from a broadly similar stratigraphic level near Perdeberg by Almond (2022b, 2022c). The Quaggasfontein limb bone appears to be too large for *Endothiodon* (*cf.* Maharaj *et al.* 2019) or other large dicynodont but this needs to be checked.

An interesting spectrum of hypichnial trace fossils attributed to sizeable temnospondyl amphibians is recorded from sole surfaces of a tabular, crevasse-splay sandstone (*c*. 20 cm thick) exposed on a hillslope just east of Quaggasfontein homestead (Figures 60 to 62). They include rare distal limb impressions (possibly 4-toed, and, if so, hands rather than feet), sharply-defined sets of straight to curved or sinuous digit furrows, as well as paired, hoof-like digital prod or scoop marks. There are also sets of bi- or tri-partite “tram lines” resembling those recorded in association with temnospondyl walking trackways from the Abrahamskraal Formation near Sutherland (Almond 2015b, Roger Smith *et al.,* work in progress). Similar digital prods and furrows, including “tramlines”, have been recorded in several Karoo Basin PIA studies in recent years, such as Almond (2022d) from the Poortjie Member near Loxton and Almond (2015c) from the Teekloof Formation near Murraysburg. Since they are usually preserved on sole surfaces, they are likely to be under-reported within Beaufort Group successions. At Quaggasfontein the traces occur in association with desiccation cracks, current- and wave-rippled bed tops, possible gypsum rose pseudomorphs and loaded beds, suggesting a lacustrine / playa lake setting. Small, elongate pelleted structures (Figure 61) may be burrow infills of infaunal invertebrates (or perhaps coprolites) which may have been an attractive food source for the temnospondyl amphibians. These trace assemblages suggest that foraging for infaunal invertebrates within river or lake bottom sediments, probing, trawling and scooping with sensitive, clawless fingertips, may have been an important feeding strategy of temnospondyl amphibians in addition to fishing within the overlying water column. While some of these traces may be locomotion or resting traces, many of them may rather belong to the category of tetrapod fodichnia (feeding traces). Cisneros *et al.* (2020) have recently described well-preserved trackways of small temnospondyls from the upper Abrahamskraal Formation near Sutherland.

Several stream bed exposures of baked, well-jointed upper Poortjie Member wackes, especially on the Farms Spes Bona 200 and Koot’s Request 148 within and on the margins of the Taaibos WEF project area, yield vague tracks and trackways of large-bodied tetrapods (Figures 63 to 74). In some cases the tracks are associated with ripple-marked and microbial-matted palaeosurfaces within thin- to medium-bedded heterolithic packages of near-channel, levee / crevasse splay delta wetland origin. The tracks are shallowly impressed into the wacke surfaces, locally retaining a mudrock infill. They are generally poorly-preserved (probably undertracks), subcircular, some 30 cm or so wide and, as far can be seen from a cursory inspection, lack clear digital impressions while well-developed asymmetrical push-ups are seen locally. In broad morphology and scale they compare most closely (*e.g.* symmetry, absence of long impressions, pes larger than manus) with the ichnogenus *Brontopus* which has been reported from the *Tapinocephalus* Assemblage Zone of the Main Karoo Basin (Marchetti *et al.* 2019b and references therein).The *Brontopus* tracks are now ascribed to dinocephalian therapsids rather than pareiasaurs which co-occur in the upper Abrahamskraal Formation (*ibid*.). Well-preserved *Brontopus* tracks show short digital impressions but these may be lost in undertracks. Their graviportal limbs may have had broad, cushioning sole pads like modern elephants. The occurrence of extensively trampled surfaces with tracks of different sizes among the new Victoria West Cluster records (Figure 72) suggests that small herds or family groups of dinocephalians congregating near waterbodies may well have been involved.

If correct, the new dinocephalian trackways would be of biostratigraphic as well as palaeobiological interest. As discussed above, the latest verified dinocephalians in the Main Karoo Basin are recorded from the lower part of the Poortjie Member and they are considered extinct by early *Endothiodon* Assemblage Zone times represented in the upper Poortjie Member (Day *et al.* 2013, Day & Smith 2020). Pareiasaur reptiles are unlikely trackmakers in the present case since they are not recorded at this stratigraphic level and their tracks are very different in morphology (*cf. Sukhonopus* in Kuznetsov 2020). Large tetrapod trackways previously reported in the Victoria West sheet area (near Richmond; Le Roux & Keyser 1988, their Figure 2.14) occur within the younger, *Cistecephalus* Assemblage Zone and are attributed to large-bodied dicynodonts such as *Aulacephalodon*. The sizeable dicynodont *Endothiodon* represented within the upper Poortjie Member is too small to have made the tracks illustrated here, while the somewhat larger dicynodont *Rhachiocephalus* first appears higher up in the Hoedemaker Member.

The only other fossil remains recorded from the Poortjie Member outcrop area in the Victoria West Cluster project area include:

- rare small (*c*. 20 cm wide) tetrapod burrows with smooth or scratch-marked ventral surfaces preserved on upper or lower bedding surfaces of wackes (Figures 75 & 76);
- poorly-preserved, low-diversity assemblages of simple invertebrate burrows assigned to the damp substrate *Scoyenia* ichnofacies (Figures 82 & 83), often associated with microbially induced sedimentary structures (MISS);
- very rare blocks of silicified wood – in this case associated with LSA stone artefact assemblages and possibly flaked, so their stratigraphic provenance is equivocal (they are possibly manuports) (Figure 85);
- local concentrations of impressions of sphenophyte fern stems (“horsetails”) in fine-grained mudrocks and associated with wetland settings along drainage lines and floodplain wetlands(Figure 84).

No fossil sites were recorded within the extensive **Late Caenozoic superficial deposits**.

Figure 55: Two *ex situ* postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur), upper Abrahamskraal Formation, Farm 261 just N of Suikerkolk farmstead (Loc. 119). Scale in cm.

Figure 56: Two *ex situ* postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur), upper Abrahamskraal Formation, Farm 261 just N of Suikerkolk farmstead (Loc. 120). Scale in cm.

Figure 57: Two *ex situ*, weathered postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur), upper Abrahamskraal Formation, *c*. 240 m WSW of Suikerkolk farmstead, Farm 261 (Loc. 127). Scale in cm and mm.

Figure 58: Two views of an isolated limb bone fragment of large-bodied tetrapod (pareiasaur reptile / dinocephalian or – less likely - dicynodont therapsid) with thin calcretised siltstone veneer in surface float, *ex situ* overlying gullied hillslope exposure of upper Poortjie Member mudrocks on Farm RE250 Quaggas Fontein (Loc. 464). Scale in cm and mm.

Figure 59: Weathered-out pedogenic calcrete concretion whose external form is strongly reminiscent of a large tetrapod limb bone, Poortjie Member on Farm RE/250 (scale = 15 cm). However, the concretion is not fossiliferous – a good example of a *pseudofossil*.

Figure 60: Prominent-weathering crevasse splay sandstone within a hillslope exposure of the upper Poortjie Member just east of Quaggasfontein homestead, Farm RE/250 Quaggas Fontein (Loc. 473) (hammer = 30 cm). Sole surfaces of downwasted sandstone blocks (in front) show abundant trace fossils ascribed to aquatic temnospondyl amphibians.

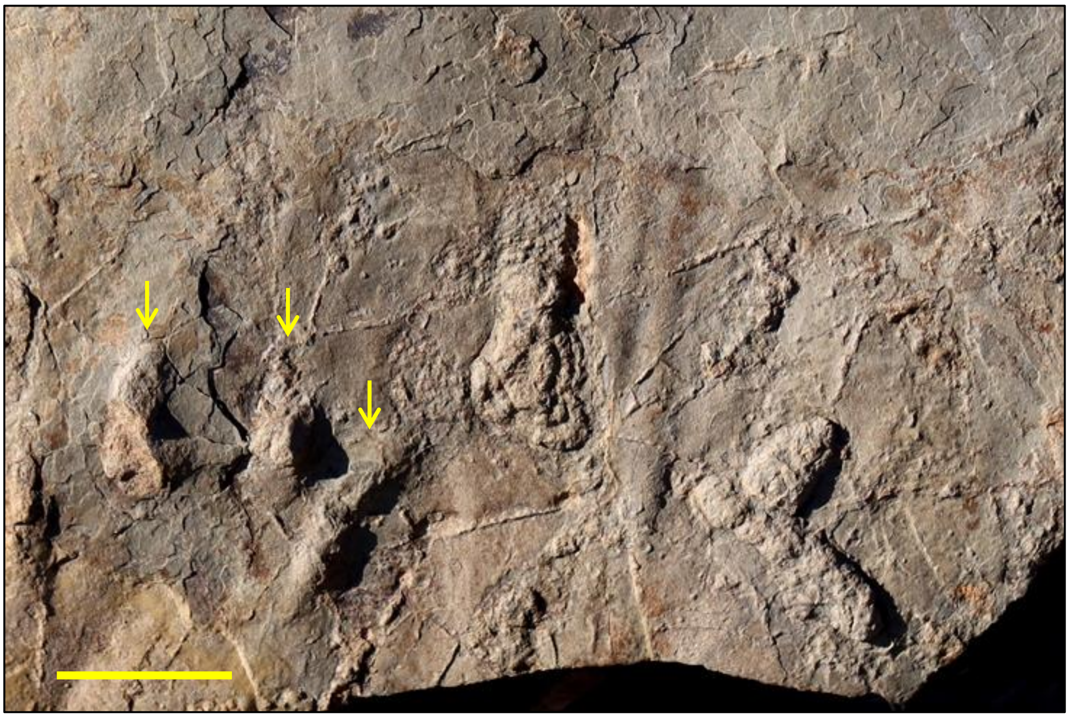

Figure 61: Desiccation-cracked sole surface of crevasse splay sandstone illustrated above with casts of digital scoop marks of a temnospondyl on the left (arrowed) and possible trace fossils of infaunal invertebrate prey (or perhaps coprolites) with a fine-scale pelleted fabric on the right. Scale bar = *c*. 3 cm.

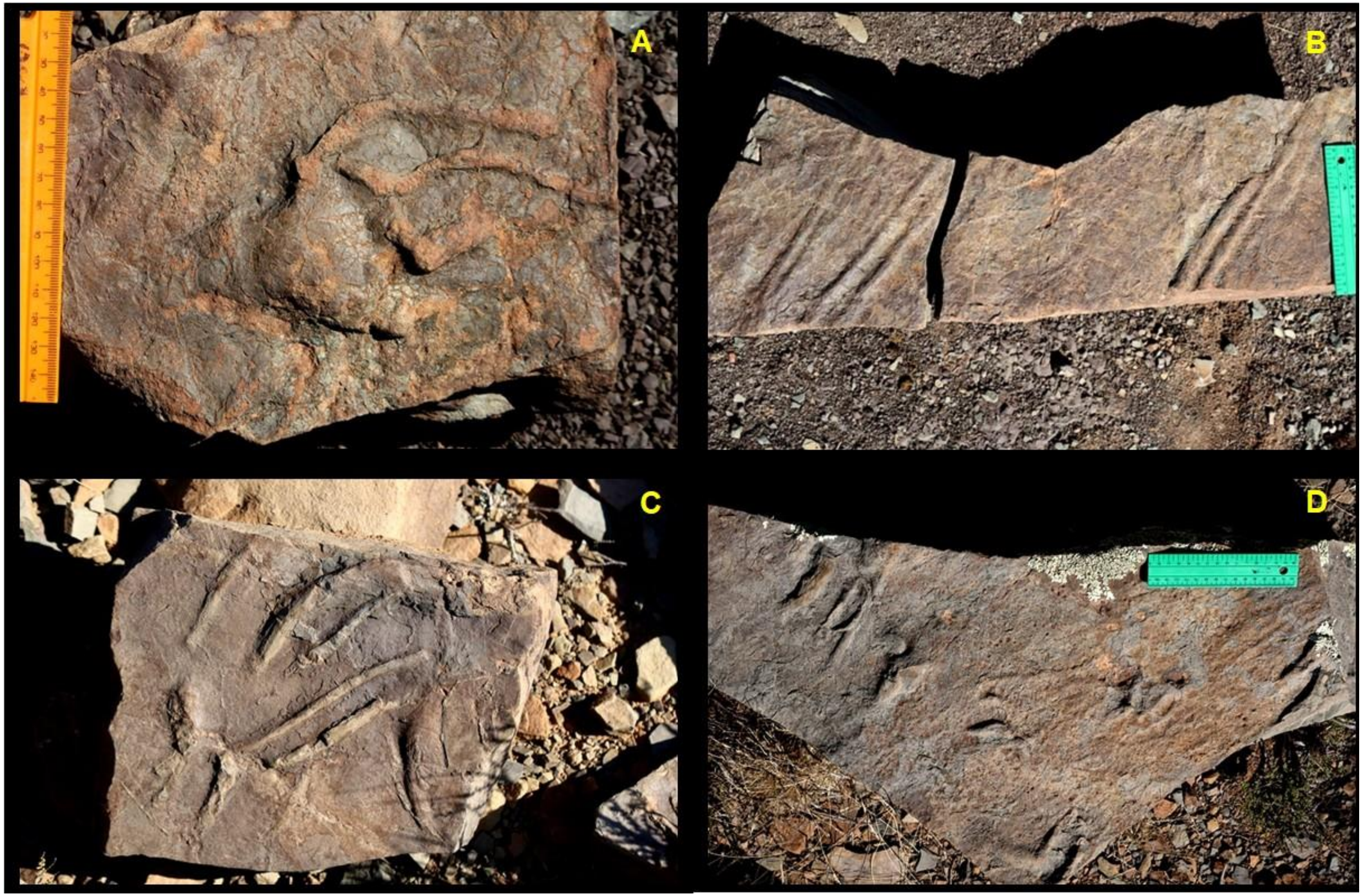

Figure 62: Temnospondyl locomotion / foraging traces on sole surfaces of crevasse splay sandstone blocks from the upper Poortjie Member on Farm RE/250 Quaggas Fontein (Loc. 473). Scales are *c*. 15 cm long. A – distal limb impression (possibly a 4-toed hand) with digital drag marks. B – double or triple "tram lines" generated by tips of digits of floating or swimming temnospondyl. C – sharply impressed digital drag or scrape marks (each *c*. 1 cm wide). D – paired digital prod or scoop marks.

Figure 63: Heterolithic, thin- to medium-bedded channel bank / crevasse splay delta package exposed along stream banks and bed with small scale wave-rippled sandstone bed tops, upper Poortjie Member, Teekloof Fm on Farm 1/200 Spes Bona (Loc. 058). The tetrapod trackways and microbial sedimentary structures illustrated in the next four figures are impressed on the bedding surface seen below and left of the hammer (*c*. 30 cm long)

Figure 64: Trackway (near hammer) on strike from the locality illustrated above, here extending into the heterolithin, thin-bedded package capped by a tabular channel sandstone unit (Loc. 060). Hammer = 30 cm.

Figure 65: Portions of the extensive, cross-cutting large tetrapod trackways (*cf Brontopus*) exposed on a stream bed within the Poortjie Member at Loc. 058 (hammer = 30 cm). Elongate composite tracks in the foreground appear to show possible overlap of the different-sized forelimb (manus) and hindlimb (pes). The axis of each component tracks is broadly parallel to the trackway itself.

Figure 66: Detail of the same tracked surface illustrated above (Loc. 058). Individual large undertracks are elliptical to subcircular, *c*. 30cm across, shallow, symmetrical, without obvious digital or claw impressions and impressed into very finely ripple-marked silty wackes which were probably bound by microbial mats.

Figure 67: Pustulose / wrinkled microbial mat texture of upper sandstone bedding plane within the heterolithic bank succession showing in Figure 63 above. Associated elongate structures (*e.g.* that arrowed on RHS, *c*. 1 cm wide) might be invertebrate trace fossils.

Figure 68: Streambed exposure of well-jointed, baked Poortjie Member wackes with several large tetrapod trackways, Farm 1/200 Spes Bona (Loc. 506). Hammer = 30 cm.

Figure 69: Another streambed exposure of well-jointed, baked Poortjie Member wackes with several large tetrapod trackways, Farm 1/200 Spes Bona (Loc. 501). Hammer = 30 cm.

Figure 70: Series are large, rounded tetrapod tracks on the inclined surface of a sand bar, Poortjie Member on on Farm 2/200 Spes Bona (Loc. 064). Hammer = 30 cm.

Figure 71: Extensive stream bed exposure of a baked, thin-bedded, heterolithic package within the Poortjie Member with *several*, subparallel large large tetrapod trackways (hammer = 30 cm), Farm 1/200 Spes Bona (Loc. 064).

Figure 72: Stream bed exposure of grey-green, fine-grained silty wacke showing dense surface trampling by large-bodied tetrapods (possibly a herd / family group), Poortjie Member on Farm 2/200 Spes Bona (Loc. 088). See also following figure.

Figure 73: Close-up of the trampled surface illustrated above showing shallow, subcircular tracks partially infilled with friable, purple-brown siltstone and asymmetric development of marginal push-ups (Loc. 088). The central depression here is *c.* 30 cm across.

Figure 74: Streambed exposure of baked Poortjie Member wackes with several large tetrapod tracks, Farm RE/148 Koot's Request (Altona) (Loc. 495). Hammer = 30 cm.

Figure 75: Stream bed exposure of baked Poortjie Member grey-green wackes with possible but *equivocal*, smooth floor of a gently curving, subhorizontal tetrapod burrow (arrowed, *c*. 15 cm wide), Farm 261 (Loc. 134).

Figure 76: Poortjie Member sandstone sole surface with densely scratch-marked ventral surface of a small tetrapod burrow (*c*. 20 cm across), Farm RE250 Quaggas Fontein (Loc. 476). Scale = 15 cm.

Figure 77: Dark grey, crumbly baked overbank mudrocks with float blocks containing scattered skeletal fragments of a small tetrapod (probably the dicynodont *Diictodon*), Poortjie Member (or possibly Hoedemaker Member) on Farm RE/149 Treurfontein (Loc. 149). Block on top LHS is 4.4 cm wide as seen here.

Figure 78: Baked grey-green mudrocks containing a poorly-preserved but articulated skeleton of a small tetrapod (probably the small dicynodont *Diictodon*), streambed exposure of the Poortjie Member on Farm 1/200 Spes Bona (Loc. 062). Scale = 15 cm.

Figure 79: Possible but equivocal sandstone burrow cast of small tetrapod containing a cluster of white bone fragments towards one end (lower LHS), Poortjie Member on Farm RE/148 Koot's Request (Altona) (Loc. 485). Scale = 15 cm. See also following figure.

Figure 80: Close-up of baked, white bone fragments seen in the previous illustration.

Figure 81: Stream bed exposure of grey-green, thin-bedded, fine-grained wackes of the Poortjie Member on Farm 2/200 Spes Bona (Loc. 087) showing pustulose microbial mat textures ("adhesion warts") and other MISS (microbially induced sedimentary structures). Scale = 15 cm.

Figure 82: Small horizontal invertebrate burrows associated with the MISS-textured palaeosurface of the Poortjie Member on Farm 2/200 Spes Bona (Loc. 087). Scale = 15 cm.

Figure 83: Float slabs of wave-rippled, grey-brown to purple-brown wacke of the Poortjie Member with low diversity, poorly preserved invertebrate burrows of the *Scoyenia* Ichnofacies, Farm 3/158 Melton Wold (Loc. 144). Scale in cm.

Figure 84: Grey-green, fine-grained mudrocks of the Poortjie Member containing concentrations of longitudinally ridged plant stem compressions – probably sphenophyte ferns or “horsetails” associated with wetland habitats, Farm 2/200 Spes Bona (Loc.097). Scale in cm and mm.

Figure 85: Later Stone Age artefact scatter among surface gravels overlying the Poortjie Member including small, possibly flaked block of finely banded petrified wood (arrowed) – perhaps a manuport collected by a hunte-gatherer , Farm 6/158 Melton Wold (Loc. 146). Scale in cm.

7. Palaeontological heritage site sensitivity verification

Provisional sensitivity mapping using the DFFE Screening Tool (Figure 86) as well as SAHRIS website indicates that the majority of the combined Victoria West Cluster project area is of Very High Palaeosensitivity, corresponding to the outcrop area of continental sediments of the Lower Beaufort Group (Karoo Supergroup). Thick alluvial deposits along major ancient to modern drainage lines (*e.g.* Brakrivier, Soutrivier) are assigned a Medium Palaeosensitivity while igneous dolerite intrusions are insensitive (*i.e.* unfossiliferous).

Based on desktop studies as well as the recent nine-day, reconnaissance-level palaeontological site visit (See Section 3.1. for data sources), it is concluded that the majority of the combined project area – apart from the insensitive dolerite intrusions - is in practice of Low Palaeosensitivity. This is largely due to the following constraints:

(1) Levels of Beaufort Group bedrock exposure are very limited here due to pervasive cover by Late Caenozoic superficial sediments (*e.g.* colluvial and eluvial gravels, alluvial and other soils);

(2) Intensive intrusion by dolerite sills and dykes has altered the sedimentary country rocks through thermal metamorphism, metasomatism and hydrothermal activity (*viz*. circulation of hot, mineralizing ground waters) which has compromised fossil preservation over large areas. Furthermore, vertebrate fossil material (silicified bones, teeth) are not readily prepared out from the matrix of tough, baked sedimentary bedrock by natural weathering processes due to their similar weathering-resistance.

(3) The Beaufort Group bedrocks represented here (uppermost Abrahamskraal Formation – Poortjie / Hoedemaker Member interval) span the catastrophic end-Middle Permian Extinction Event which is associated with an unusually low abundance of well-preserved fossil remains. Over the course of nine days, only a handful of vertebrate body fossil sites were recorded within Beaufort Group bedrocks within the Victoria West Cluster project area, the majority of which are poorly preserved and of limited scientific or conservation significance. Even occasional small areas showing excellent, fresh (*i.e.* unweathered) mudrock exposure ideal for palaeontological recording yielded hardly any fossils. Very few historical fossil sites are recorded here on geological maps and palaeontological databases (*e.g.* Nicolas 2007) while recent field-based PIA studies report very low concentrations of vertebrate fossils in the Loxton Area (Almond 2022d).

(4) No fossil sites were recorded within the Late Caenozoic superficial deposits.

Several fossil trackway sites of scientific importance and high palaeosensitivity have been recorded along drainage lines within the project area (Appendix 1). While additional, unrecorded fossil sites of significant palaeontological and conservation value are likely to occur at and beneath the land surface within the Victoria West Cluster project area, they are probably very sparse and sporadic in distribution. Since such sites are usually unpredictable, a specialist palaeontological walk-down of the authorized WEF infrastructure layouts is recommended in the Pre-Construction Phase. Any additional fossils discovered during the Construction Phase are best handled through a Chance Fossil Finds Protocol (See Appendix 2). New trackway sites are likely to be already protected within standard ecological buffer zones along drainage lines; if not, they will require protection within a buffer zone of *c*. 20 m radius. The great majority of newly recorded skeletal fossils (*i.e.* bones, teeth) can, if necessary, be effectively mitigated through professional recording and collection.

It is concluded that the palaeosensitivity of the combined Victoria West Cluster project area is, in practice, generally LOW with occasional, small and largely unpredictable areas of HIGH sensitivity, most of which lie along drainage lines. The provisional palaeosensitivity mapping by the DFFE Screening Tool is accordingly *contested* in this report.

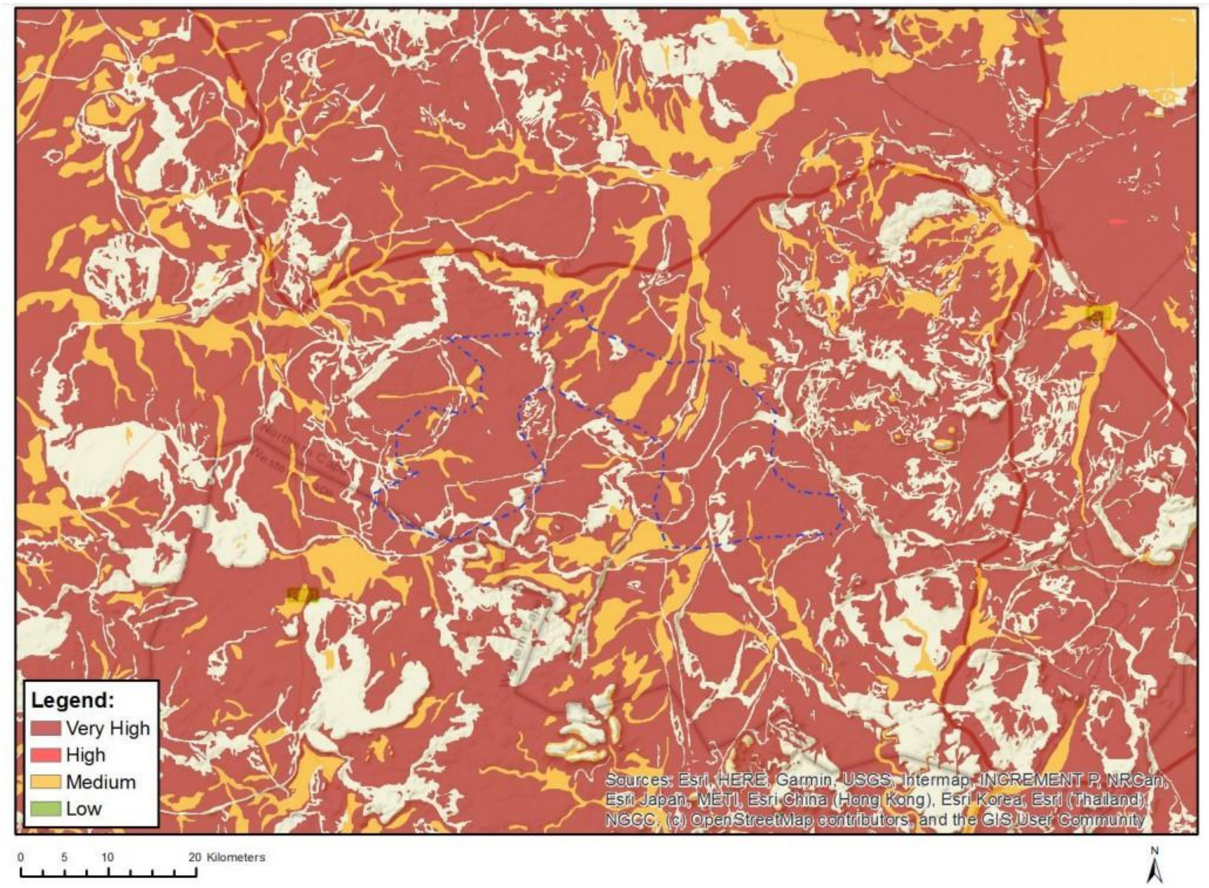

Figure 86: Provisional palaeosensitivity of the combined Victoria West Cluster project area between Victoria West and Loxton, Northern Cape (blue polygon) based on the DFFE Screening Tool (Abstracted from screening report provided by CES Consulting, dated September 2021).

8. Potential impacts on palaeontological heritage and mitigation

8.1. Existing impacts

Existing impacts on local palaeontological heritage resources within the combined Victoria West Cluster project area include (1) background low-level damage to, or loss of, fossils exposed at the ground surface due to small-stock farming (*e.g.* vehicle activity, irrigation infrastructure, small-scale agriculture) as well as (2) on-going natural weathering and erosion processes that both destroy fossil material as well as expose and prepare-out previously-buried fossils. Loss of fossils though illegal collection is unlikely to be a major factor at present.

8.2. Construction Phase Impacts

The Construction Phase of the proposed Victoria West Cluster renewable energy projects will involve substantial surface clearance and bedrock excavations - for example for wind turbine and solar panel foundations, access road networks, underground cables, construction laydown areas/camps, operation & maintenance buildings, on-site substations and electrical pylon footings - which may disturb, damage or destroy legally projected palaeontological heritage resources of scientific and conservation value.

A high level palaeontological heritage impact assessment for renewable energy projects within the Victoria West Cluster is provided in Table 1 below. A Low Palaeosensitivity has been assigned in this study to the combined project area (Section 7), with only ~30 new fossil sites recorded here during the reconnaissance-level site visits. Nevertheless, a precautionary approach is adopted here regarding palaeontological heritage mitigation because several of the new fossil sites are of significant scientific and conservation value and important new sites may still be found. Palaeontological heritage impacts are anticipated to be Low (Negative), both before and following mitigation. A substantial and worthwhile reduction in impact significance is expected where previously unrecorded fossil sites of high scientific value are identified and mitigated in the Pre-Construction or Construction Phase. This analysis applies equally to all the component renewable energy projects (WEFs / SEFs) and is for the Construction Phase; significant further impacts during the Operational and De-commissioning Phases are not anticipated.

The potential for further, unrecorded palaeontological sites of high scientific and conservation value within the very large project area cannot be excluded. These sites are best identified and mitigated through (1) a specialist palaeontological heritage walk-down of the authorized WEF footprints in the Pre-Construction Phase and (2) the application of a Chance Fossil Finds Protocol by the ECO / ESO during the Construction Phase (See Appendix 3) which should be incorporated into the EMPrs for the WEF and SEF developments. The qualified palaeontologist responsible for mitigation work will need to apply for a Fossil Collection Permit for the Northern Cape from SAHRA. Minimum standards for PIA reports have been compiled by Heritage Western Cape (2021) and SAHRA (2013).

8.3. Cumulative Impacts

According to the DFFE REEA website (2022, Q2) comparatively few renewable energy projects have been authorised or proposed until recently between Loxton and Victoria West. However, a substantial number of WEF and SEF projects are listed in the vicinity of Victoria West itself; PIAs for the latter (where available) have been briefly reviewed by Almond (2022b). The most relevant projects for the Victoria West Cluster for which PIA studies are available – mostly compiled by the present author - include the existing Noblesfontein WEF (desktop PIA only by Almond 2015a) and adjoining Modderfontein WEF (Almond 2021), Nuweveld WEF projects and associated grid connection (Almond 2020a-d), Hoogland North WEF cluster (Almond 2022a), Mura PV Solar projects (Almond 2022c), Gamma Gridline (Almond 2022b), iLanga Emoyeni Solar Suite (Almond 2022e) as well as on-going studies for the Loxton WEF Cluster (Almond 2022d).

In most of these cases the project areas were assessed on the basis of desktop and field-based studies as being in practice of Low Palaeosensitivity but with scattered, and largely unpredictable, High Sensitivity fossil sites of scientific and conservation value. Impact significance following mitigation is Low in most cases.

Anticipated cumulative impacts on local palaeontological heritage due to the various Victoria West WEF and SEF projects in the context of existing or proposed renewable energy projects between Loxton and Victoria West listed above are anticipated to be Low (Negative) and to fall within acceptable limits. This assessment is based largely on the paucity of significant fossil sites recorded hitherto within the combined cluster project area and assumes that the proposed Pre-Construction and Construction Phase mitigation measures recommended for all these projects are implemented in full.

Table 1: Assessment and mitigation of impacts on Palaeontological Heritage Resources relating to each of the proposed WEF and SEF components of the Victoria West Cluster (Construction Phase)*

DESCRIPTION OF IMPACTS	SPATIAL SCALE (EXTENT)	TEMPORAL SCALE (DURATION)	CERTAINTY SCALE/ PROBABILITY	SEVERITY/ CONSEQUENCE	SIGNIFICANCE PRE-MITIGATION	REVERSIBILITY / MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
Issue: Palaeontological heritage resources							
Disturbance, damage, destruction or sealing-in of legally protected, scientifically valuable fossil remains preserved at or beneath the ground surface within the development footprint, especially during ground clearance or bedrock excavations during the Construction Phase.	**Localised (infra-structure footprint)**	**Long Term (Permanent)**	**May occur**	**MODERATE NEGATIVE (but might be locally HIGH NEGATIVE)**	**LOW/ NEGATIVE**	**Impact severity can be effectively (albeit only partially) mitigated through:** • **Pre-construction walk-down of authorized project footprint by specialist palaeontologist in the Pre-Construction Phase** • **Ongoing monitoring for fossil remains of all substantial bedrock excavations and surface clearance activities by ECO during Construction Phase, with safeguarding and reporting of new palaeontological finds (notably fossil vertebrate bones & teeth) to SAHRA for possible specialist mitigation (See appended Chance Fossil Finds Protocol).**	**LOW/ NEGATIVE (but may be partially offset by professional recording and collection of new fossil finds = compensatory positive outcome)**

**N.B.* This high level assessment applies equally to all the proposed renewable energy developments within the Victoria West Cluster.
Analysis refers to fossil sites of scientific and / or conservation significance.
Further significant impacts are not anticipated in the Operational and Decommissioning Phases of each renewable energy development.

9. Conclusions and recommendations

The combined project area for the Victoria West Cluster renewable energy developments is underlain by potentially fossiliferous continental (fluvial / lacustrine) sediments assigned to the Lower Beaufort Group (Abrahamskraal and Teekloof Formations) of Middle to Late Permian age. This sector of the Upper Karoo between Loxton and Victoria West is largely unexplored in palaeontological terms and the local stratigraphy is poorly resolved. Provisional palaeosensitivity mapping of this very large project area by the DFFE Screening Tool suggests that the majority is of Very High Sensitivity. However, desktop studies as well as a recent 9-day palaeontological site visit show that, in practice, fossil remains are very scarce here with only ~30 new sites recorded, most of which are of limited scientific and conservation value. The majority of new fossil sites are from the Poortjie Member (lowermost Teekloof Formation) and lie along drainage lines. They mainly comprise trackways of large-bodied tetrapods (probably dinocephalians), very rare skeletal remains of large tetrapods (unidentified possible pareiasaur reptiles / dinocephalians or possibly dicynodont therapsids) and small dicynodonts, small tetrapod burrows, feeding / locomotion traces of large temnospondyl amphibians and of infaunal invertebrates as well as scarce fossil plant material. The scarcity of fossils here is in large part due to the very poor levels of bedrock exposure - especially as regards potentially fossiliferous mudrock facies - as well as extensive regional thermal metamorphism of the Beaufort Group sediments by igneous intrusions, especially shallow saucer-shaped dolerite sills. It is concluded that the palaeosensitivity of the project area is generally Low but with significant potential for unrecorded, largely unpredictable sites of high scientific and conservation value. The provisional palaeosensitivity mapping by the DFFE Screening Tool is accordingly *contested* in this report.

None of the known fossil sites of scientific or conservation value lies within or close to the footprints of the proposed renewable energy facilities. Furthermore, most of the recorded sites will be protected within standard ecological buffer zones along drainage lines and no mitigation is recommended in their regard. Given the potential for additional but unrecorded fossil sites of scientific value within the extensive project area, a specialist palaeontological heritage walk-down of the authorized WEF / SEF project footprints is recommended in the Pre-Construction Phase. The Chance Fossil Finds Protocol tabulated in Appendix 2 should be implemented during the Construction Phase. Recommended Mitigation and Management of palaeontological heritage for the Victoria West Cluster is summarized in tabular form in Appendix 3.

Palaeontological heritage impacts due to the proposed Victoria West Cluster renewable energy projects are anticipated to be Low (Negative), both before and following mitigation. A substantial and worthwhile reduction in impact significance is expected where previously unrecorded fossil sites of high scientific value are identified and mitigated in the Pre-Construction or Construction Phase. This analysis applies equally to all the component renewable energy projects (WEFs / SEFs) and is for the Construction Phase; significant further impacts during the Operational and De-commissioning Phases are not anticipated.

Anticipated cumulative impacts on local palaeontological heritage due to the various Victoria West WEF and SEF projects in the context of existing or proposed renewable energy projects between Loxton and Victoria West are anticipated to be Low (Negative) and to fall within acceptable limits. This assessment is based largely on the paucity of significant fossil sites recorded hitherto within the combined cluster project area and assumes that the proposed Pre-Construction and Construction Phase mitigation measures recommended for all these projects are implemented in full.

The proposed Victoria West Cluster renewable energy projects are not fatally flawed and there are no objections in terms of palaeontological heritage to their receiving environmental authorization. The recommended palaeontological heritage mitigation outlined in Table 1 and Section 9.1 below as well as summarized in the Chance Fossil Finds Protocol appended to this report (Appendix 2) should be included within the EMPr for each development.

9.1. Palaeontological heritage input into the EMPRs

Despite the scarcity of recorded fossil sites in the region, the potential for further, unrecorded palaeontological sites of high scientific and conservation value within the very large Victoria West Cluster project area cannot be excluded. These sites are best identified and mitigated through (1) a specialist palaeontological heritage walk-down of the authorized WEF and SEF footprints in the Pre-Construction Phase and (2) the application of a Chance Fossil Finds Protocol by the ECO / ESO during the Construction Phase (See Appendix 2) which should be incorporated into the EMPrs for the WEF and SEF developments. The qualified palaeontologist responsible for mitigation work will need to apply for a Fossil Collection Permit for the Northern Cape from SAHRA. Fossil material collected must be curated, together with pertinent collection data, within an approved repository (*e.g.* museum or university collection). Minimum standards for PIA reports have been compiled by Heritage Western Cape (2021) and SAHRA (2013). Recommended Mitigation and Management Measures regarding palaeontological heritage within the Victoria West Cluster project areas are summarized in tabular form in Appendix 3.

10. Acknowledgements

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12. Outline of specialist's experience

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

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

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

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

APPENDIX 1: GPS LOCALITY DATA – VICTORIA WEST CLUSTER BETWEEN LOXTON & VICTORIA WEST, NORTHERN CAPE PROVINCE (September 2022)

GPS readings were taken in the field using a hand-held Garmin GPSmap 64s instrument. The datum used is WGS 84. . *Note that locality data for South African fossil sites in not for public release due to conservation concerns.*

Recorded fossil sites are tabulated below, together with GPS data, brief description, Proposed Field Rating and any recommended mitigation. They are mapped in the context of the Victoria West Cluster project areas and proposed renewable energy facility layouts on satellite images in Figures A1.1 to A1.8 below. The fossil sites tabulated and mapped here obviously do not (and cannot) represent *all* fossil sites at surface within the extensive combined Victoria West Cluster project area but, at most, a *representative sample* of these. Therefore the absence of recorded fossil sites in a particular area does *not* mean that fossils are not present here at surface or in the subsurface. For this reason, a pre-construction palaeontological heritage walkdown of the authorised WEF and SEF footprints is recommended here and a Chance Fossil Finds Protocol for the Construction Phase is appended to this report.

Loc.	GPS data	Comments
058	-31.548691° 22.576488°	Farm 1/200 Spes Bona Poortjie Member, Teekloof Fm Heterolithic, thin- to medium-bedded channel bank / crevasse splay delta package exposed along stream banks and bed with small scale wave-rippled sandstone bed tops, pustulose microbial mat textures, horizontal invertebrate burrows, long trackway(s) of large-bodied graviportal tetrapod(s) without clear toe impressions (possibly undertracks). Proposed Field Rating IIIB. Protected within ecological buffer zone along drainage line – no mitigation recommended.
060	-31.548712° 22.575945°	Farm 1/200 Spes Bona Poortjie Member, Teekloof Fm heterolithic thin-bedded package exposed along stream banks and bed. Trackway of large tetrapod extending into heterolithic package capped by channel sandstone exposed along river bank. Possible extension of tracks at Loc. 058. Proposed Field Rating IIIB. Protected within ecological buffer zone along drainage line – no mitigation recommended.
062	-31.546893° 22.571800°	Farm 1/200 Spes Bona Poortjie Member, Teekloof Fm Baked grey-green mudrocks with pale pedocrete concretion horizons, calcretised mud cracks, poorly-preserved, baked skeleton of a small tetrapod (probably *Diictodon*). Proposed Field Rating IIIB. Protected within ecological buffer zone along drainage line – no mitigation recommended.
064	-31.548052° 22.566332°	Farm 1/200 Spes Bona Poortjie Member, Teekloof Fm Extensive stream bed exposure of thin-bedded, heterolithic package, *c*. 15cm thick, well-jointed baked wacke bed with *several*, subparallel large tetrapod trackways (one may ascend low bar), vague trampled areas, possible but equivocal sandstone casts of tetrapod burrows, isolated small bone fragment within baked grey mudrock. Proposed Field Rating IIIB. Protected within ecological buffer zone along drainage line – no mitigation recommended.
087	-31.606732° 22.563592°	Farm 2/200 Spes Bona Poortjie Member, Teekloof Fm Stream bed exposures of grey-green, thin-bedded, fine-grained wackes, multiple palaeosurfaces with mudcracks, pustulose microbial mat textures (“adhesion warts”), microripples, tesselated surfaces and other MISS, simple horizontal invertebrate burrows (*c*. 5mm wide) Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
088	-31.606621° 22.562702°	Farm 2/200 Spes Bona Poortjie Member, Teekloof Fm

		Stream bed exposure of grey-green, fine-grained silty wacke with probable surface trampling by large-bodied tetrapods, putative footprints sometimes with push-up margins and infilled with purple-brown siltstone. Clear trackways not discernible. Proposed Field Rating IIIB. Protected within ecological buffer zone along drainage line – no mitigation recommended.
097	-31.581908° 22.571161°	Farm 2/200 Spes Bona Poortjie Member, Teekloof Fm Narrow stream gulley exposure of purple-brown and grey-green, fine-grained mudrocks, latter locally with concentrations of longitudinally ridged plant stem compressions – probably sphenophyte ferns (3 cm or less in diameter). Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
119	-31.505905° 22.660483°	Farm 261 just N of Suikerkolk farmstead Abrahamskraal Formation Hillslope exposures of grey-green mudrocks just east of N-S trending dolerite dyke along ridge crest. Two *ex situ* postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur). Proposed Field Rating IIIB. Site lies well outside project footprint so no mitigation recommended.
120	-31.506223° 22.660534°	Farm 261 *c*. 400m north of Suikerkolk farmstead Abrahamskraal Formation Hillslope exposures of grey-green mudrocks just east of N-S trending dolerite dyke along ridge crest. Two *ex situ* postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur). Proposed Field Rating IIIB. Site lies well outside project footprint so no mitigation recommended.
127		Farm 261 Abrahamskraal Formation gentle slopes of grey-green and purple-brown mudrocks *c*. 240 m WSW of Suikerkolk farmstead. Two *ex situ*, weathered postcranial bone fragments of a large tetrapod (dinocephalian or pareiasaur). Proposed Field Rating IIIB. Site lies well outside project footprint so no mitigation recommended.
134	-31.503308° 22.673865°	Farm 261 Poortjie Member Stream bed exposure of grey-green wackes with possible but *equivocal*, smooth floor of a gently curving, subhorizontal tetrapod burrow (*c*. 15 cm wide). Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
135	-31.503075° 22.673799°	Farm 261 Poortjie Member Small stream bed exposure of jointed wacke with possible but *equivocal* tracks of a large tetrapod. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
144	-31.554196° 22.734887°	Farm 3/158 Melton Wold Upper part of Poortjie Member Float slabs of wave-rippled, grey-brown to purple-brown wacke with low diversity invertebrate burrows of the *Scoyenia* Ichnofacies. Proposed Field Rating IIIC. No mitigation recommended.
146	-31.573008° 22.786583°	Farm 6/158 Melton Wold Poortjie Member Late Stone Age artefact scatter including small (c. 2 cm diam.), possibly flaked block of petrified wood – perhaps a manuport. Proposed Field Rating IIIC. No mitigation recommended.
149	-31.609410° 22.822378°	Farm RE/149 Treurfontein Poortjie Member (or *possibly* Hoedemaker Member)

		Thick package of dusky purple-grey mudrock, fine-grained baked wacke, baked calcrete horizons. Dark grey, crumbly baked overbank mudrocks with float blocks containing scattered skeletal fragments of a small tetrapod (probably the dicynodont *Diictodon*). Proposed Field Rating IIIC. No mitigation recommended.
464	-31.620284° 22.519073°	Farm RE250 Quaggas Fontein Poortjie Member gullied hillslope exposures of purple-brown and grey-green siltstone with pedocrete horizons, thin crevasse-splay sandtones (wave rippled) *c*. 400 m N of Quaggasfontein Farmstead. Isolated limb bone end fragment of large-bodied tetrapod (pareiasaur reptile or dinocephalian therapsid, or possibly large dicynodont) with thin calcretised siltstone veneer in surface float. Proposed Field Rating IIIB. Original specimen collected. Site lies well outside project footprint so no mitigation recommended.
467-473	Approx. -31.622427° 22.521644° southwards to -31.623246° 22.521363° (See red polygon in Figure A1.4)	Farm RE/250 Quaggas Fontein WNW-facing Hillslope mudrock exposure of Poortjie Member just east of Quaggasfontein Homestead. Prominent-weathering crevasse splay sandstone (*c*. 20-30 cm thick) small scale wave ripples on bed top. Sole surfaces of downwasted blocks showing variety of temnospondyl amphibian digital prods, grooves, occasional foot impression, invertebrate traces (or possibly coprolites). Proposed Field Rating IIIB. Site lies well outside project footprint so no mitigation recommended.
476	-31.616454° 22.482487°	Farm RE/250 Quaggas Fontein Poortjie Member grey mudrocks with float blocks of crevasse splay or thin channel sandstone on hilltop. Sandstone sole surface with scratch-marked ventral surface of small tetrapod burrow (*c*. 20 cm across). Vague, simple horizontal invertebrate burrows preserved as positive or negative features on sandstone bedding planes. Proposed Field Rating IIIC. No mitigation required.
484	-31.512933° 22.539423°	Farm RE/148 Koot's Request (Altona) Poortjie Member exposures of pale brown wackes and grey-green mudrocks along stream bed and banks. Poorly preserved horizontal burrows on bedding planes of baked channel wackes, equivocal vertebrate burrow casts. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
485	-31.510931° 22.540476°	Farm RE/148 Koot's Request (Altona) Poortjie Member exposures of pale brown wackes and grey-green mudrocks along stream bed and banks. Cluster of small baked bone fragments (baked white) of small tetrapod, possibly within sandstone burrow cast. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
491	-31.508098° 22.566492°	Farm RE/148 Koot's Request (Altona) Poortjie Member, river bed exposure of baked purple-brown and greyish mudrocks, desiccation cracks, thin crevasse splay sandstones. Poorly preserved impressions / compression moulds of longitudinally ridged plant stems (probably equisetalean ferns) within fine-grained mudrocks. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
493	-31.509770° 22.577108°	Farm RE/148 Koot's Request (Altona) Poortjie Member, extensive river bed exposures of tabular-bedded, baked wackes, siltstones. Possible but *equivocal* terapod-trampled palaeosurface with large, shallow, rounded depressions. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
494	-31.507222° 22.586055°	Farm RE/148 Koot's Request (Altona)

		Poortjie Member, stream bed exposure of wackes with possible but equivocal tetrapod tracks. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
495	-31.506882° 22.586162°	Farm RE/148 Koot's Request (Altona) Poortjie Member, stream bed exposure of baked, highly jointed wackes with several probable large tetrapod tracks. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
497	-31.506813° 22.587230°	Farm RE/148 Koot's Request (Altona) Poortjie Member, stream bed exposure of wackes with possible but equivocal tetrapod tracks. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
501	-31.570758° 22.589657°	Farm 1/200 Spes Bona Streambed exposures of well-jointed, baked Poortjie Member wackes with surfaces possibly trampled by large tetrapods (equivocal trackways). Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
502	-31.570709° 22.589693°	Farm 1/200 Spes Bona Streambed exposures of well-jointed, baked Poortjie Member wackes with surfaces possibly trampled by large tetrapods (equivocal trackways). Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
506	-31.570762° 22.588349°	Farm 1/200 Spes Bona Streambed exposures of well-jointed, baked Poortjie Member wackes with probable large tetrapod trackways. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
507	-31.571122° 22.588278°	Farm 1/200 Spes Bona Streambed exposures of well-jointed, baked Poortjie Member wackes with bedding surfaces possibly trampled by large tetrapods. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.
509	-31.572167° 22.589366°	Farm 1/200 Spes Bona Streambed exposures of well-jointed, baked Poortjie Member wackes with bedding surfaces possibly trampled by large tetrapods. Proposed Field Rating IIIC. Protected within ecological buffer zone along drainage line – no mitigation recommended.

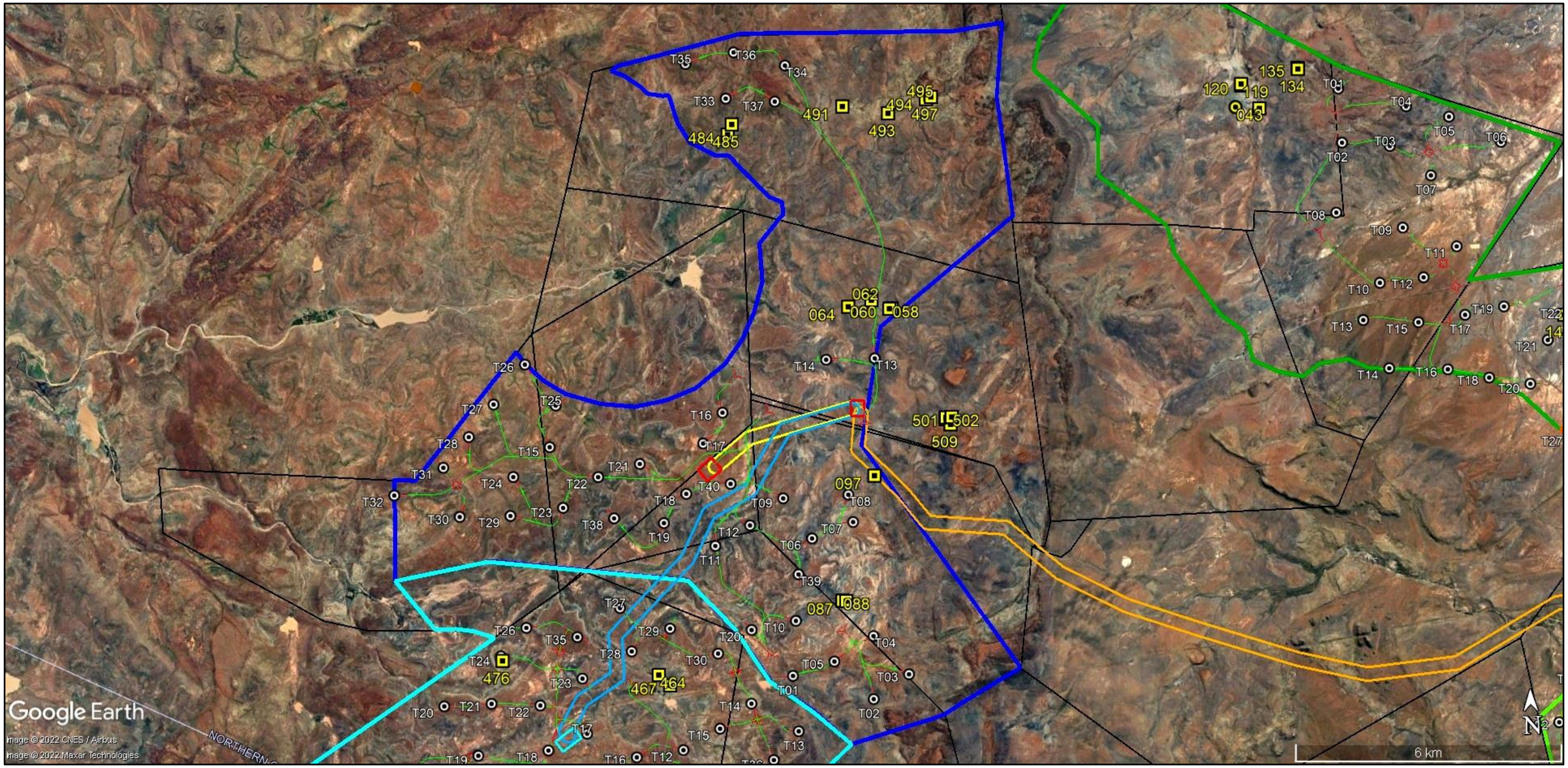

Figure A1.1: GoogleEarth© satellite image of the Taaibos North WEF project area (dark blue polygon) showing recorded fossil sites (numbered yellow squares) in relation to provisional layout of key WEF infrastrastructure, *viz*: wind turbine locations (numbered white circles) with hardstands and temporary laydown areas (red), new internal access road network (green lines), on-site substation compound (western red square), Taaibos collector substation (eastern red square), 300m wide powerline corridor between on-site substation and collector substation (yellow), 300m wide corridor for 400 kV line between Soutrivier and Taaibos collector stations (orange; see Figure A1. 7 for eastern continuation of corridor). None of the recorded fossil sites lies inside or within 20 m of the proposed WEF footprint and no palaeontological mitigation is proposed with regard to them. See also following figure for more detail.

Figure A1.2: Detail of the Taaibos North WEF project area and marginal areas illustrated above showing the location of several poorly-preserved trackways of large bodied tetrapods along stream beds on Farm 1/200 Spes Bona (Locs. 058, 060, 064, 501, 502, 506, 507, 509). Several of these sites lie *outside* and east of the WEF project area. It is anticipated that further unrecorded trackway sites occur in similar settings within the Victoria West Cluster project area. Such sites are generally protected within standard ecological buffer zones along drainage lines.

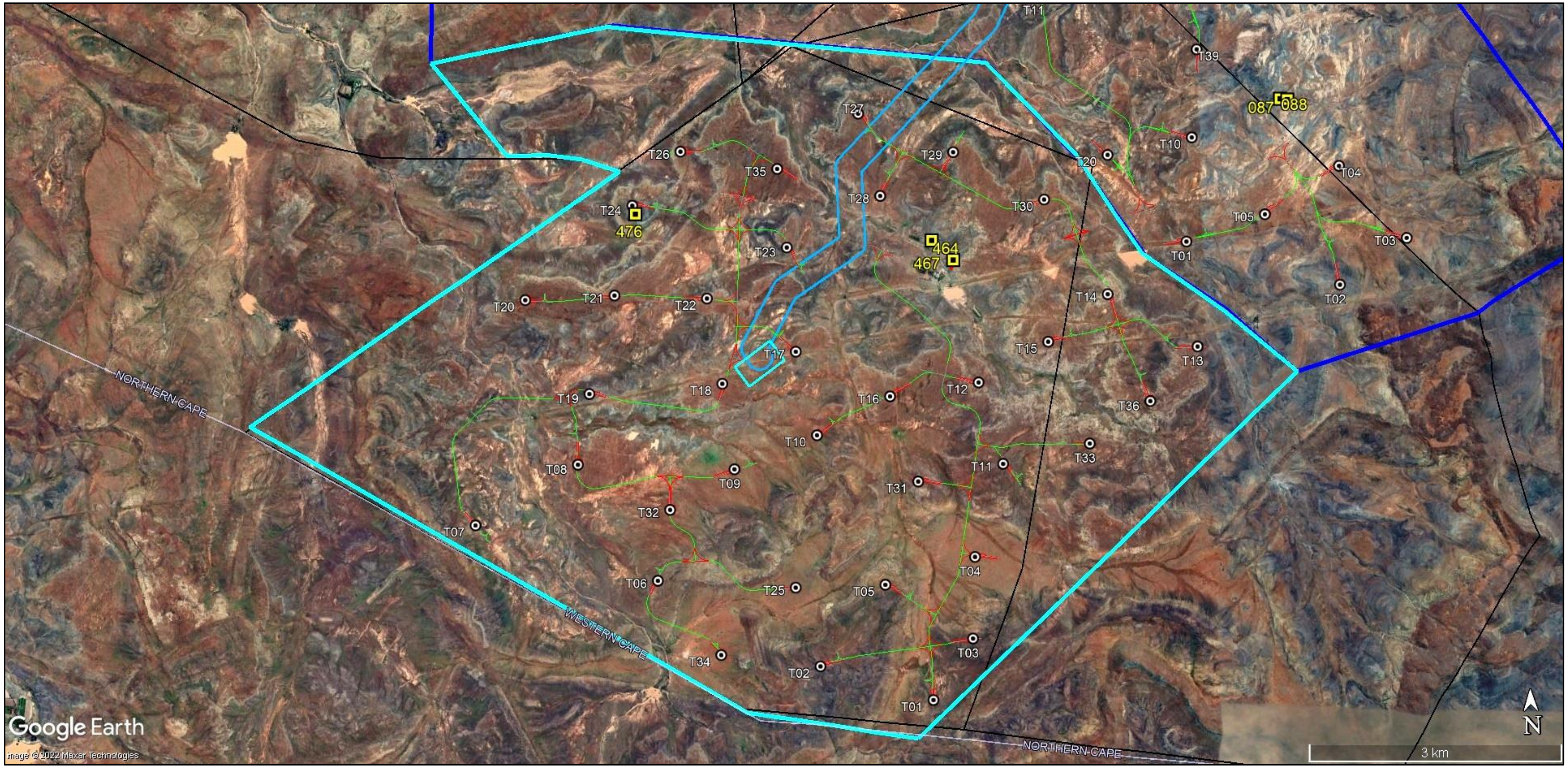

Figure A1.3: GoogleEarth© satellite image of the Taaibos South WEF project area (pale blue polygon) showing recorded fossil sites (numbered yellow squares) in relation to provisional layout of key WEF infrastrastructure, *viz*: wind turbine locations (numbered white circles) with hardstands and temporary laydown areas (red), new internal access road network (green lines), on-site substation compound (pale blue rectangle), 300m wide powerline corridor to Taaibos Collector Station (middle blue; see Figure A1.1 for northern continuation of corridor). None of the recorded fossil sites lies inside or within 20 m of the proposed footprint and no palaeontological mitigation is proposed with regard to them. Sites 464 and 467 are shown in more detail in the following figure.

Figure A1.4: Detail of the Taaibos South WEF project area shown above showing fossil sites in the vicinity of Quaggasfontein homestead on Farm RE/250 Quaggas Fontein. The *ex situ* tetrapod bone at Loc. 464 has been collected. The elongate red shape at Loc. 467 encloses a dense scatter of temnospondyl amphibian traces of scientific interest. It lies well outside the development footprint and so no special mitigation is recommended here.

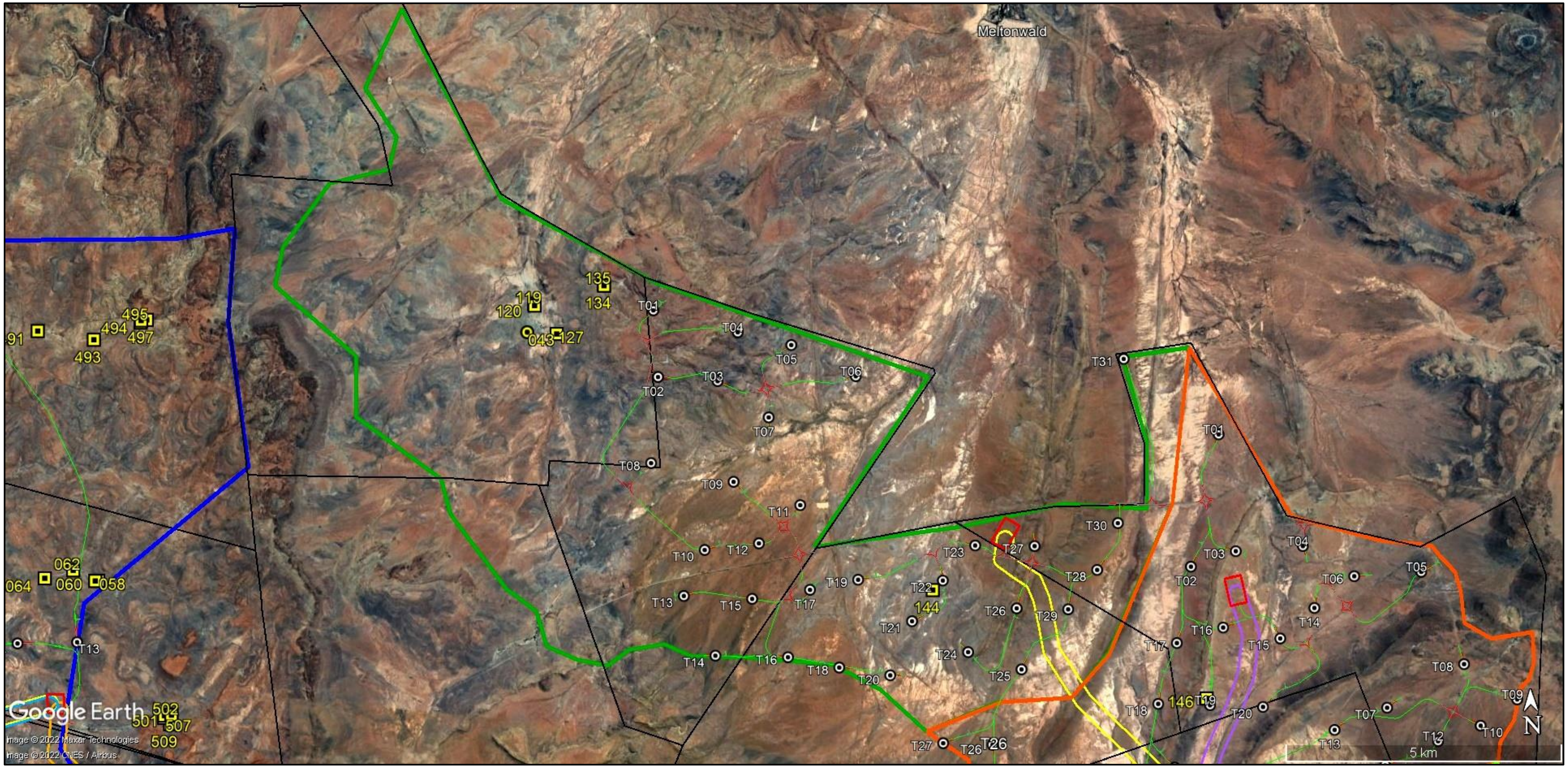

Figure A1.5: GoogleEarth© satellite image of the Soutrivier North WEF project area (dark green polygon) showing recorded fossil sites (numbered yellow squares) in relation to provisional layout of key WEF infrastructure, *viz*: wind turbine locations (numbered white circles) with hardstands and temporary laydown areas (red), new internal access road network (green lines), on-site substation compound (red rectangle), 300m wide powerline corridor between on-site substation and Soutrivier collector substation (yellow; see Figure A1.6 for southern continuation of corridor). None of the recorded fossil sites lies inside or within 20 m of the proposed WEF footprint and no palaeontological mitigation is proposed with regard to them. *Note that access to Farm 2/199 Slypfontein was not available during the palaeontological site visits so a pre-construction palaeontological walkdown of the authorised WEF footprint here is essential.*

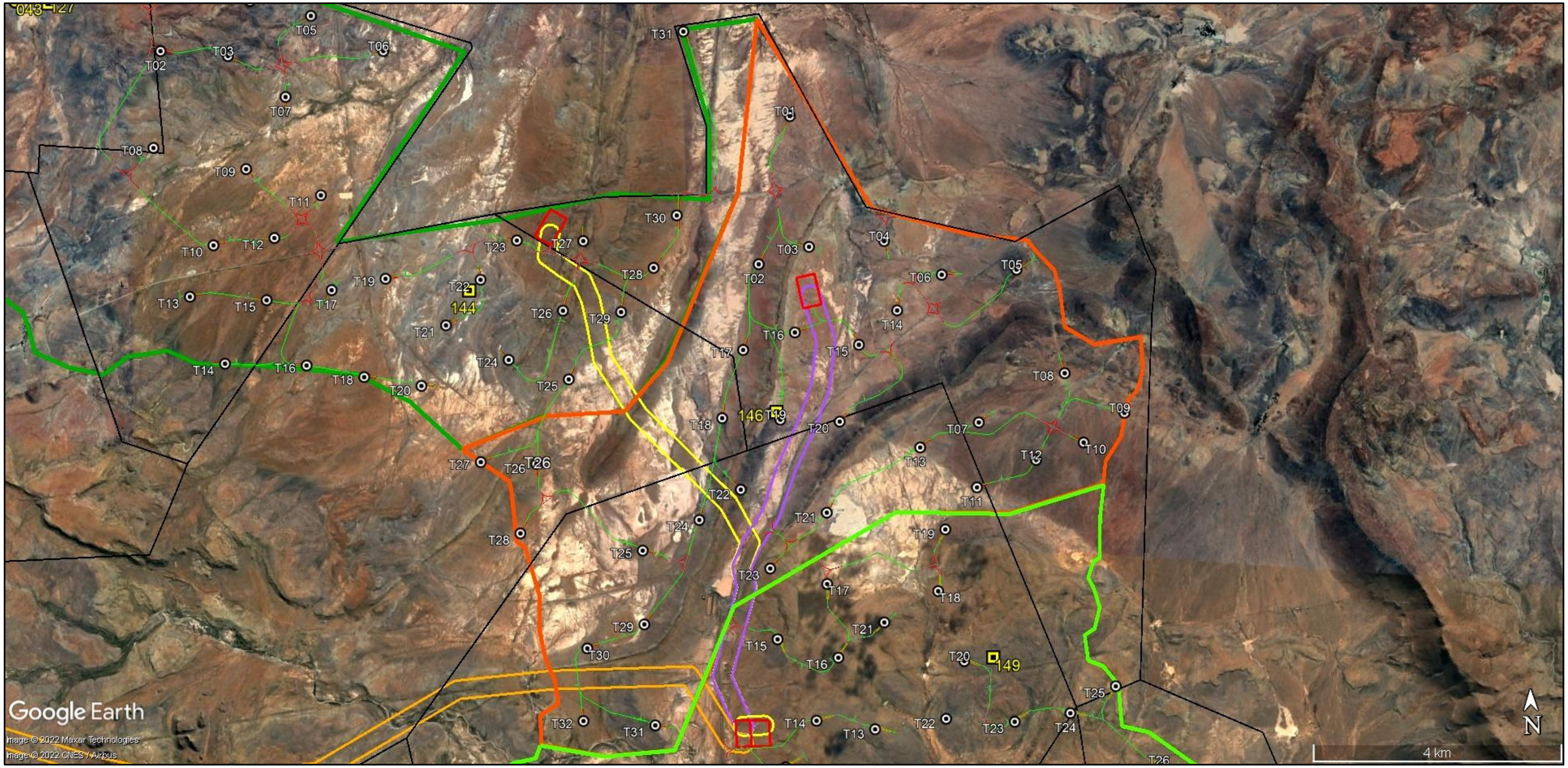

Figure A1.6: GoogleEarth© satellite image of the Soutrivier Central WEF project area (orange polygon) showing recorded fossil sites (numbered yellow squares) in relation to provisional layout of key WEF infrastrastructure, *viz*: wind turbine locations (numbered white circles) with hardstands and temporary laydown areas (red), new internal access road network (green lines), on-site substation compound (red rectangle), 300m wide powerline corridor between on-site substation and Soutrivier collector substation (lilac). None of the recorded fossil sites lies inside or within 20 m of the proposed WEF footprint and no palaeontological mitigation is proposed with regard to them.

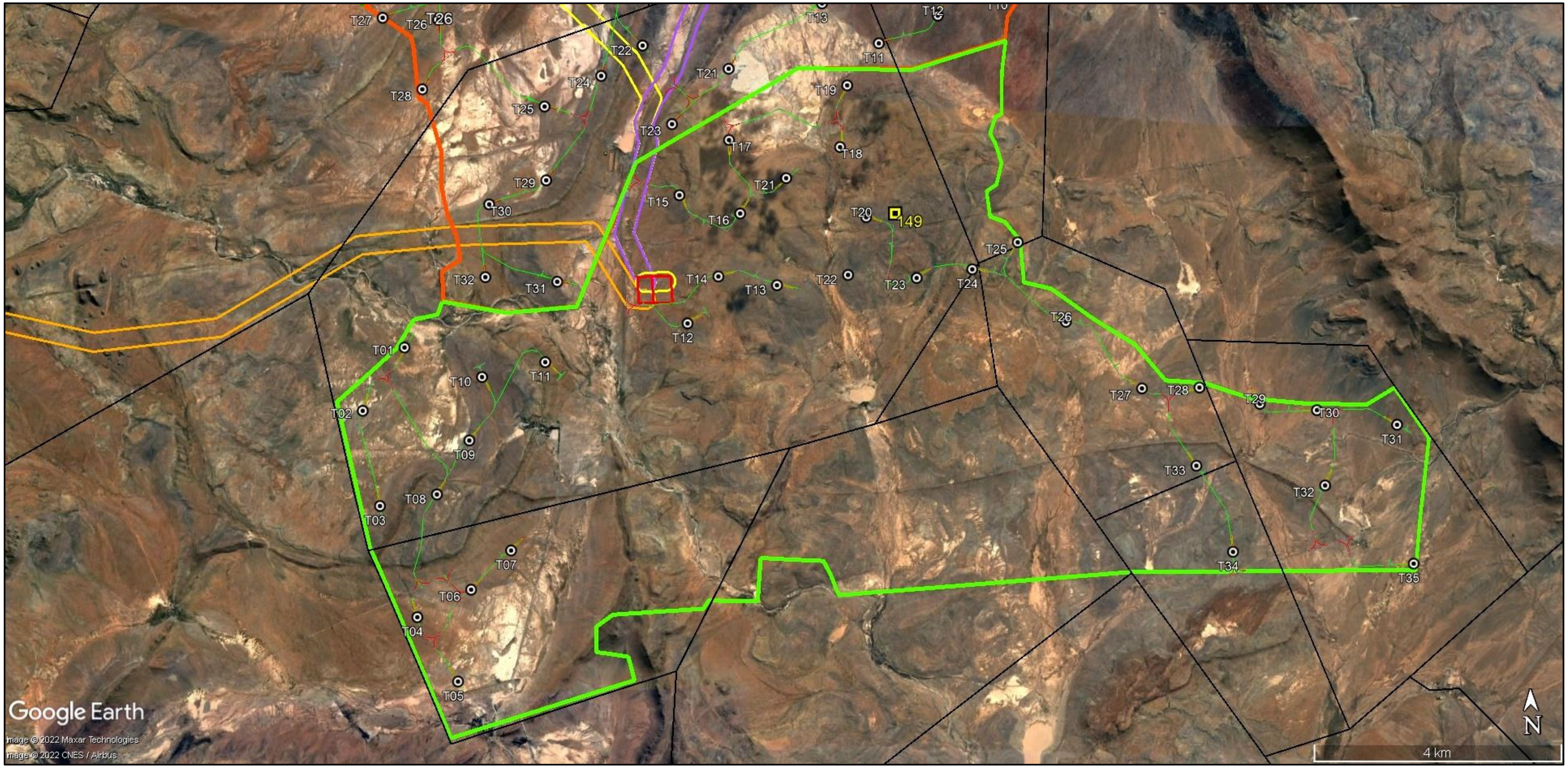

Figure A1.6: GoogleEarth© satellite image of the Soutrivier South WEF project area (light green polygon) showing recorded fossil sites (numbered yellow squares) in relation to provisional layout of key WEF infrastrastructure, *viz*: wind turbine locations (numbered white circles) with hardstands and temporary laydown areas (red), new internal access road network (green lines), on-site substation compound (red rectangle), 300m wide powerline corridor between on-site substation and Soutrivier collector substation (yellow). None of the recorded fossil sites lies inside or within 20 m of the proposed WEF footprint and no palaeontological mitigation is proposed with regard to them.

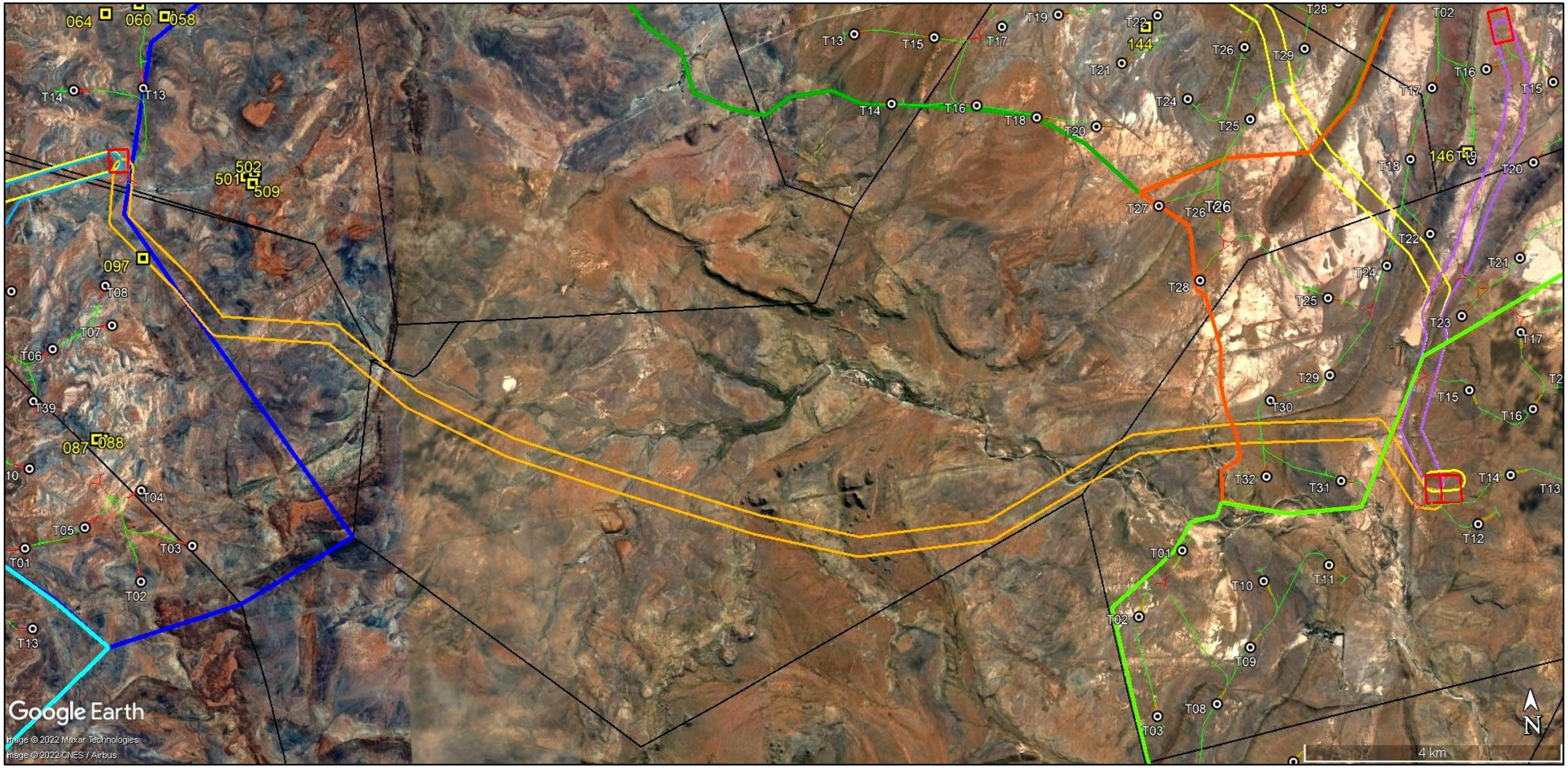

Figure A1.7: GoogleEarth© satellite image showing the 300m wide 400 kV powerline corridor (orange) connecting the Taaibos collector substation in the west and the Soutrivier collector substation in the east (red rectangles). Fossil site Loc. 097 refers to scrappy plant remains of low scientific and conservation value for which no mitigation is recommended. ***Very little time was spent within the 400 kV powerline corridor during the reconnaissance-level site visits so a pre-construction palaeontological walkdown of the authorised powerline footprint here is essential.***

<table>
<tr><th colspan="3">APPENDIX 2 - CHANCE FOSSIL FINDS PROCEDURE: Victoria West WEF Cluster between Loxton and Victoria West, Northern Cape Province</th></tr>
<tr><td>Province & region:</td><td colspan="2">Northern Cape (Pixley Ka-Seme District, Ubuntu Local Municipality)</td></tr>
<tr><td>Responsible Heritage Management Agencies</td><td colspan="2">SAHRA for N. Cape: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal Formation and Teekloof Formation (Lower Beaufort Group), Late Caenozoic alluvium.</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil skulls, postcrania of tetrapods, amphibians, fish as well as rare petrified wood, vertebrate and invertebrate burrows within bedrocks. Mammalian bones, teeth & horn cores, freshwater molluscs, calcretised trace fossils & rhizoliths and plant material in alluvium.</td></tr>
<tr><td rowspan="5">ECO / ESO 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">Apply for Fossil Collection Permit Record / submit Work Plan to the relevant Heritage Resources Agency. Describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>

APPENDIX 3: PALAEONTOLOGICAL HERITAGE MITIGATION & MANAGEMENT: Victoria West Cluster between Loxton & Victoria West, Northern Cape Province					
Impact/Aspect	**Mitigation/Management Actions**	***Responsibility***	***Methodology***	**Mitigation/Management Objectives and Outcomes**	***Frequency***
PRE-CONSTRUCTION PHASE					
Disturbance, damage or destruction of fossil remains preserved at or below the ground surface through site clearance of bedrock excavations.	Pre-construction palaeontological heritage walkdown.	Specialist palaeontologist appointed by developer	Cross-checking of final authorized layout against satellite imagery & fossil database to identify unsurveyed, potentially sensitive sectors of project footprint (if any). Pre-construction walkdown of sensitive sectors with recording and judicious collection of fossil material within and close to final project footprint. Curation of fossils and site data within an approved repository (museum / university palaeontological collection)	Conservation and recording of fossil material of scientific / conservation value located within project footprint	Before construction starts.
	Palaeontological mitigation reporting to responsible Heritage Resources Agency (PRHA)	Specialist palaeontologist	Submission of Fossil Collection Report to responsible Heritage Resources Agency (PRHA)		
CONSTRUCTION PHASE					
Disturbance, damage or destruction of fossil remains preserved at or below the ground surface through site clearance of bedrock excavations.	Monitoring of substantial, deeper excavations (> 1m)	ECO / ESO	Visual inspection of excavations Application of Chance Fossil Finds Protocol Safeguarding newly exposed fossils - *in situ*, if feasible – pending mitigation.	Reporting and safeguarding of significant new fossil finds (*e.g.* vertebrate bones, teeth, petrified wood, shells) to SAHRA for potential mitigation.	Ongoing throughout Construction Phase
	Submission of Work Plan to / application for Fossil Collection permit from responsible Heritage Resources Agency (PRHA) Recording and sampling / collection of significant new fossil finds that have been reported by ECO / ESO	Specialist palaeontologist appointed by developer	Recording of fossil material as well as associated geological data. Professional sampling / collection of fossils. Curation of fossils and site data within an approved repository (museum / university palaeontological collection)	Conservation and recording of new fossil material of scientific / conservation value within project area	Triggered by alert from ECO / ESO / PHRA
	Palaeontological mitigation reporting to responsible Heritage Resources Agency (PRHA)	Specialist palaeontologist	Submission of Fossil Collection Report to responsible Heritage Resources Agency (PRHA)	Conservation and recording of new fossil material of scientific / conservation value within project area	Following specialist palaeontological mitigation

APPENDIX 5: SPECIALIST PALAEONTOLOGIST CURRICULUM VITAE - JOHN E. ALMOND Ph.D. (Cantab)

***Natura Viva* cc, 76 Breda Park, Breda Street, Oranjezicht, CAPE TOWN 8001, RSA**
Tel: (021) 462 3622 e-mail: naturaviva@universe.co.za

- **Honours Degree in Natural Sciences (Zoology)**, University of Cambridge, UK (1980).

- **PhD in Earth Sciences (Palaeontology)**, University of Cambridge, UK (1986).

- **Post-doctoral Research Fellowships** at University of Cambridge, UK and Tübingen University, Germany (Humboldt Research Fellow).

- **Visiting Scientist** at various research institutions in Europe, North America, South Africa and fieldwork experience in all these areas, as well as in North Africa.

- **Scientific Officer, Council for Geoscience, RSA** (1990-1998) – palaeontological research and fieldwork – especially in western RSA and Namibia.

- **Managing Member, *Natura Viva* cc** – a Cape Town-based company specialising in broad-based natural history education, tourism and research – especially in the Arid West of Southern Africa (2000 onwards). *Natura Viva* cc produces **technical reports** on palaeontology, geology, botany and other aspects of natural history for public and private nature reserves.

- **Current palaeontological research** focuses on fossil record of the Precambrian / Cambrian boundary (especially trace fossils), and the Cape Supergroup of South Africa.

- **Registered Field Guide** for **South Africa** and **Namibia**

- **Member of the A-team, Botanical Society of SA** (Kirstenbosch Branch) – involved in teaching and training leaders for botanical excursions. Invited leader of annual Botanical Society excursions (Kirstenbosch Branch) to Little Karoo, Cederberg, Namaqualand and other areas since 2005.

- **Professional training of Western and Eastern Cape Field Guides** (FGASA Level 1 & 2, in conjunction with *The Gloriosa Nature Company*) and of Tourist Guides in various aspects of natural history.

- Involved in **extra-mural teaching in natural history** since the early 1980s. Extensive experience in **public lecturing**, running **intensive courses** and leading **field excursions for professional academics as well as enthusiastic amateurs** (*e.g.,* Geological Society / Archaeological Society / Friends of the SA Museum / Cape Natural History Club / Mineral Club / Botanical Society of South Africa / SA Museum Summer & Winter School Programmes / UCT Summer School)

- **Development of palaeontological teaching materials** (textbooks, teachers guides, palaeontological displays) and **teacher training** for the new school science curriculum (GET, FET).

- Former long-standing member of **Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC)**. Advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA (including APM Permit Committee at HWC). Compilation of **technical reports on provincial palaeontological heritage of Western, Northern and Eastern Cape** for SAHRA and HWC. Accredited member of PSSA and APHP (Association of Professional Heritage Practitioners, Western Cape).

- **Palaeontological impact assessments for developments in the Western Cape, Eastern Cape, Northern Cape, Free State, Northwest Province, Mpumulanga, Gauteng, KwaZulu-Natal.**

- Several hundred **palaeontological heritage desktop studies and field assessments** completed over the past few years. Examples of recent larger projects include:

(1) Numerous major alternative energy projects (wind / solar) in the Beaufort West, Sutherland, Tanqua Karoo, Kuruman, Prieska, De Aar, Loeriesfontein, Bedford / Cookhouse / Middleton / Somerset East, Kouga, Coega, East London and Uitenhage areas (N. Cape, E. Cape)

(2) Palaeontological heritage survey of the Coega IDZ (E. Cape)

(3) Surveys of borrow pits in the Western Cape

(4) Palaeontological heritage assessments for the Transnet 16 mtpa railway development, Hotazel to Coega IDZ (N. Cape, E. Cape)

(5) Eskom transmission line developments such as Gamma-Omega and Gamma Perseus projects (N. Cape, W. Cape, Free State)

(6) Mining exploration studies on the Great Karoo, Northern Cape

(7) Strategic Environmental Assessment Specialist Report – Heritage (palaeontological component) National Wind and Solar PV, Shale Gas in the Karoo, Square Kilometre Array (Karoo), Aquaculture.

- **Reviews of fossil heritage** related to new 1: 250 000 geological maps published by the Council for Geoscience (Geological Survey of SA) – *e.g.,* Clanwilliam, Loeriesfontein, Alexander Bay sheets.

APPENDIX 5: TABULATED PROJECT DESCRIPTIONS FOR THE VICTORIA WEST RENEWABLE ENERGY CLUSTER

1. Soutrivier Central WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 32
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m
BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 32 turbines = 96 000 m^2 which equates to **9.6 ha**	TOTAL 3000 m^2 x 32 turbines = 96 000 m^2 which equates to **9.6 ha**
Temporary Laydown Area	TOTAL 3000 m^2 x 32 turbines = 96 000 m^2 which equates to **9.6 ha**	TOTAL 0 m^2 x 32 turbines = 0m^2 which equates to 0 **ha**
Turbine Foundation	TOTAL Up to 900m^2 x 32 turbines = 28 800 m^2 which equates to **2.88 ha**	TOTAL Up to 900m^2 x 32 turbines = 28 800 m^2 which equates to **2.88 ha**
WEF Substation	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 32 000 m x 14m = 448 000 m^2 which equates to 44.8 **ha**	TOTAL (better estimate coming with civil layout) 32 000 m x 8m = 256 000 m^2 which equates to 25.6 **ha**
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 32 000 m x 14m = 448 000 m^2 which equates to 44.8 **ha**	TOTAL (better estimate coming with civil layout) 32 000 m x 8m = 256 000 m^2 which equates to 25.6 **ha**
TOTAL FOOTPRINT:	**124.68 ha *of clearing needed for the construction phase***	**76.68 ha *of clearing remaining during the post-construction operational phase***

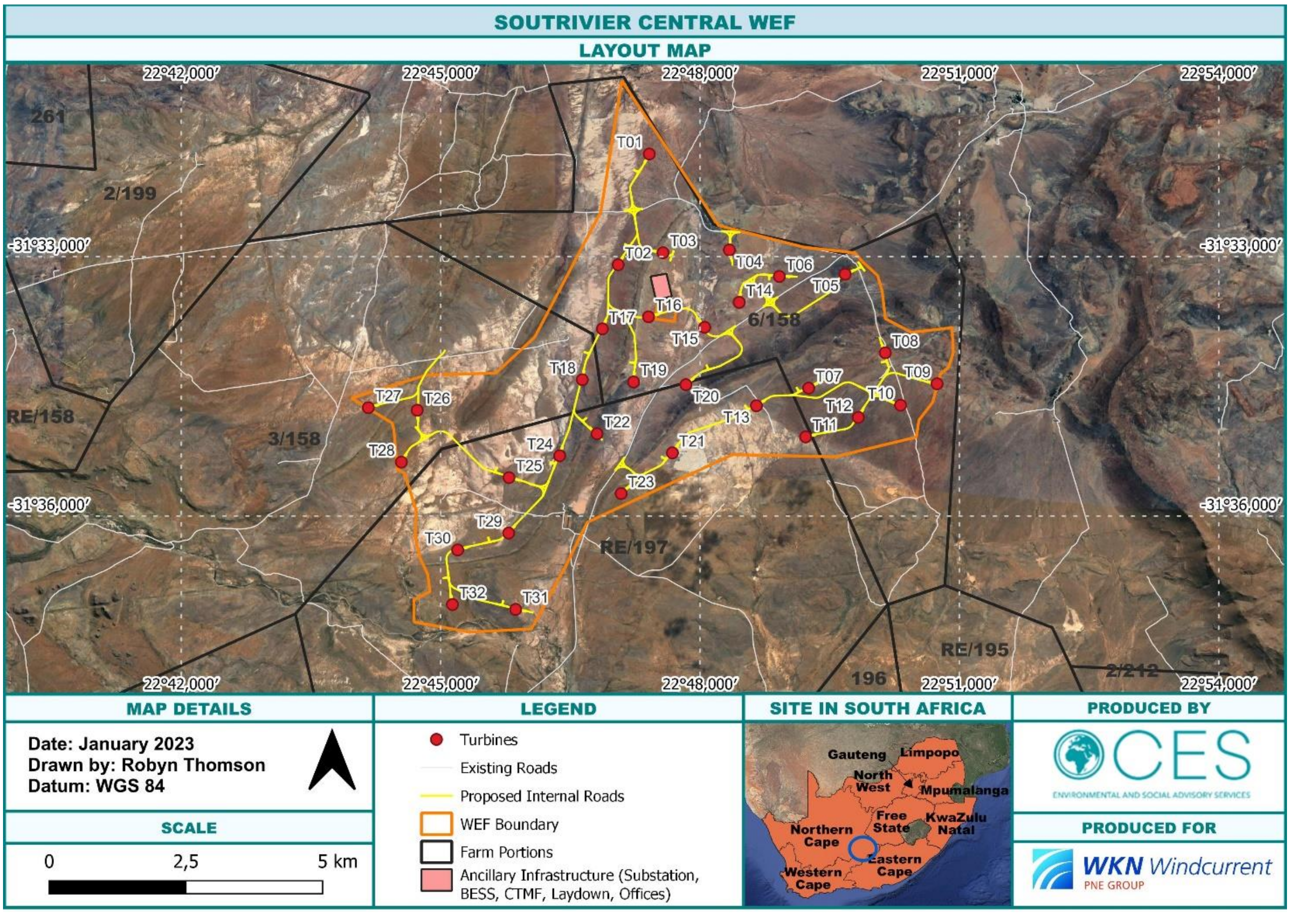

Figure above: Layout map of Soutrivier Central WEF

2. Soutrivier North WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 31
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m
BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 31 turbines = 93 000 m^2 which equates to **9.3 ha**	TOTAL 3000 m^2 x 31 turbines = 93 000 m^2 which equates to **9.3 ha**
Temporary Laydown Area	TOTAL 3000 m^2 x 31 turbines = 93 000 m^2 which equates to **9.3 ha**	TOTAL 0 m^2 x turbines = 0m^2 which equates to 0 **ha**
Turbine Foundation	TOTAL Up to 900m^2 x 31 turbines = 27 900 m^2 which equates to **2.79 ha**	TOTAL Up to 900m^2 x 31 turbines = 27 900 m^2 which equates to **2.79 ha**
WEF Substation	33/132kV Substation – 1.5ha	33/132kV Substation – 1.5ha

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
	Offices and parking – 0.5ha Permanent Laydown – 1ha	Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 31 000 m x 14m = 434 000 m^2 which equates to 43.4 **ha**	TOTAL (better estimate coming with civil layout) 31 000 m x 8m = 248 000 m^2 which equates to 24.8 **ha**
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 31 000 m x 14m = 434 000 m^2 which equates to 43.4 **ha**	TOTAL (better estimate coming with civil layout) 31 000 m x 8m = 248 000 m^2 which equates to 24.8 **ha**
TOTAL FOOTPRINT:	**121.19 ha *of clearing needed for the construction phase***	**74.69 ha *of clearing remaining during the post-construction operational phase***

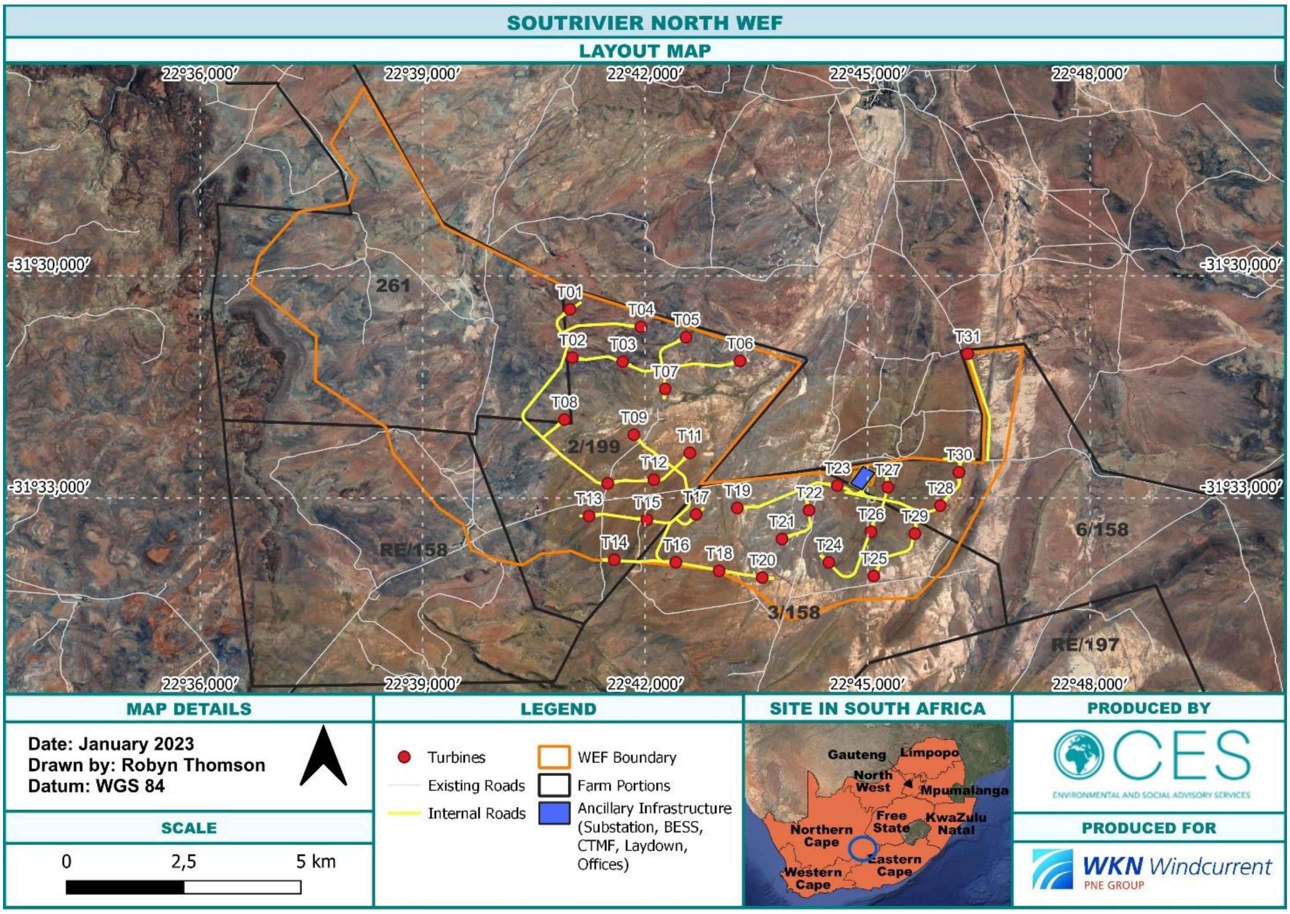

Figure above: Layout map of Soutrivier North WEF

3. Soutrivier South WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 35
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m
BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 35 turbines = 105 000 m^2 which equates to 10.5 **ha**	TOTAL 3000 m^2 x 35 turbines = 105 000 m^2 which equates to 10.5 **ha**
Temporary Laydown Area	TOTAL 3000 m^2 x 35 turbines = 105 000 m^2 which equates to 10.5 **ha**	TOTAL 0 m^2 x 35 turbines = 0m^2 which equates to 0 **ha**
Turbine Foundation	TOTAL Up to 900m^2 x 35 turbines = 31 500 m^2 which equates to **3.15 ha**	TOTAL Up to 900m^2 x 35 turbines = 31 500 m^2 which equates to **3.15 ha**
WEF Substation	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
Collector Substation	10ha	10ha
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 35 000 m x 14m = 490 000 m^2 which equates to 49.0 **ha**	TOTAL (better estimate coming with civil layout) 35 000 m x 8m = 280 000 m^2 which equates to 28.0 **ha**
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 35 000 m x 14m = 490 000 m^2 which equates to 49.0 **ha**	TOTAL (better estimate coming with civil layout) 35 000 m x 8m = 280 000 m^2 which equates to 28.0 **ha**
TOTAL FOOTPRINT:	**145.15 ha *of clearing needed for the construction phase***	**92.65 ha *of clearing remaining during the post-construction operational phase***

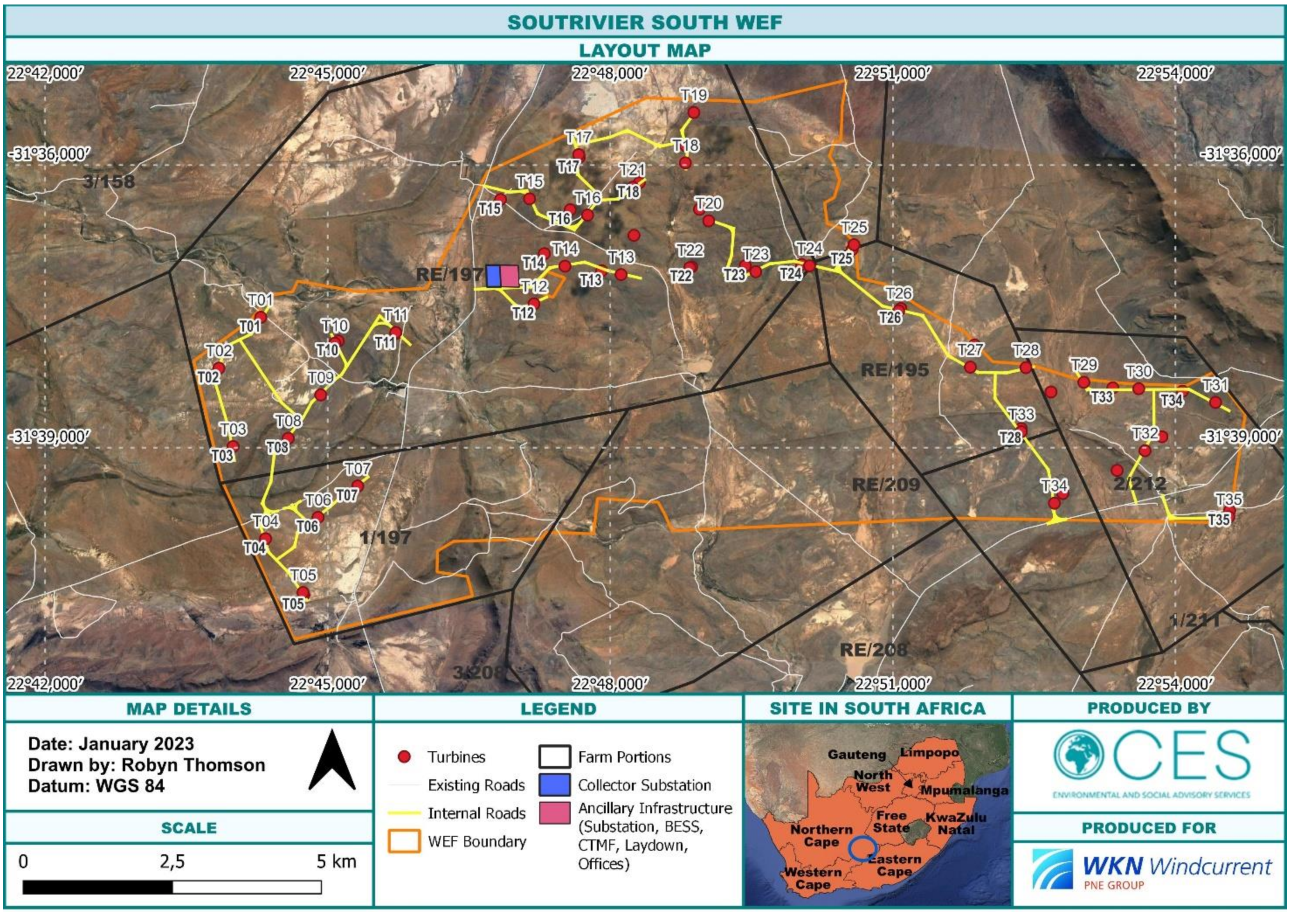

Figure above: Layout map of Soutrivier South WEF

4. Taaibos North WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 40
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m
BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 40 turbines = 120 000 m^2 which equates to 12.0 **ha**	TOTAL 3000 m^2 x 40 turbines = 120 000 m^2 which equates to 12.0 **ha**
Temporary Laydown Area	TOTAL 3000 m^2 x 40 turbines = 120 000 m^2 which equates to 12.0 **ha**	TOTAL 0 m^2 x 40 turbines = 0m^2 which equates to 0 **ha**
Turbine Foundation	TOTAL Up to 900m^2 x 40 turbines = 36 000 m^2	TOTAL Up to 900m^2 x 40 turbines = 36 000 m^2

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
	which equates to **3.6 ha**	which equates to **3.6 ha**
WEF Substation	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
Collector Substation	10ha	10ha
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 40 000 m x 14m = 560 000 m^2 which equates to 56.0 **ha**	TOTAL (better estimate coming with civil layout) 40 000 m x 8m = 320 000 m^2 which equates to 32.0 **ha**
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 40 000 m x 14m = 560 000 m^2 which equates to 56.0 **ha**	TOTAL (better estimate coming with civil layout) 40 000 m x 8m = 320 000 m^2 which equates to 32.0 **ha**
TOTAL FOOTPRINT:	***159.6 ha of clearing needed for the construction phase***	***99.6 ha of clearing remaining during the post-construction operational phase***

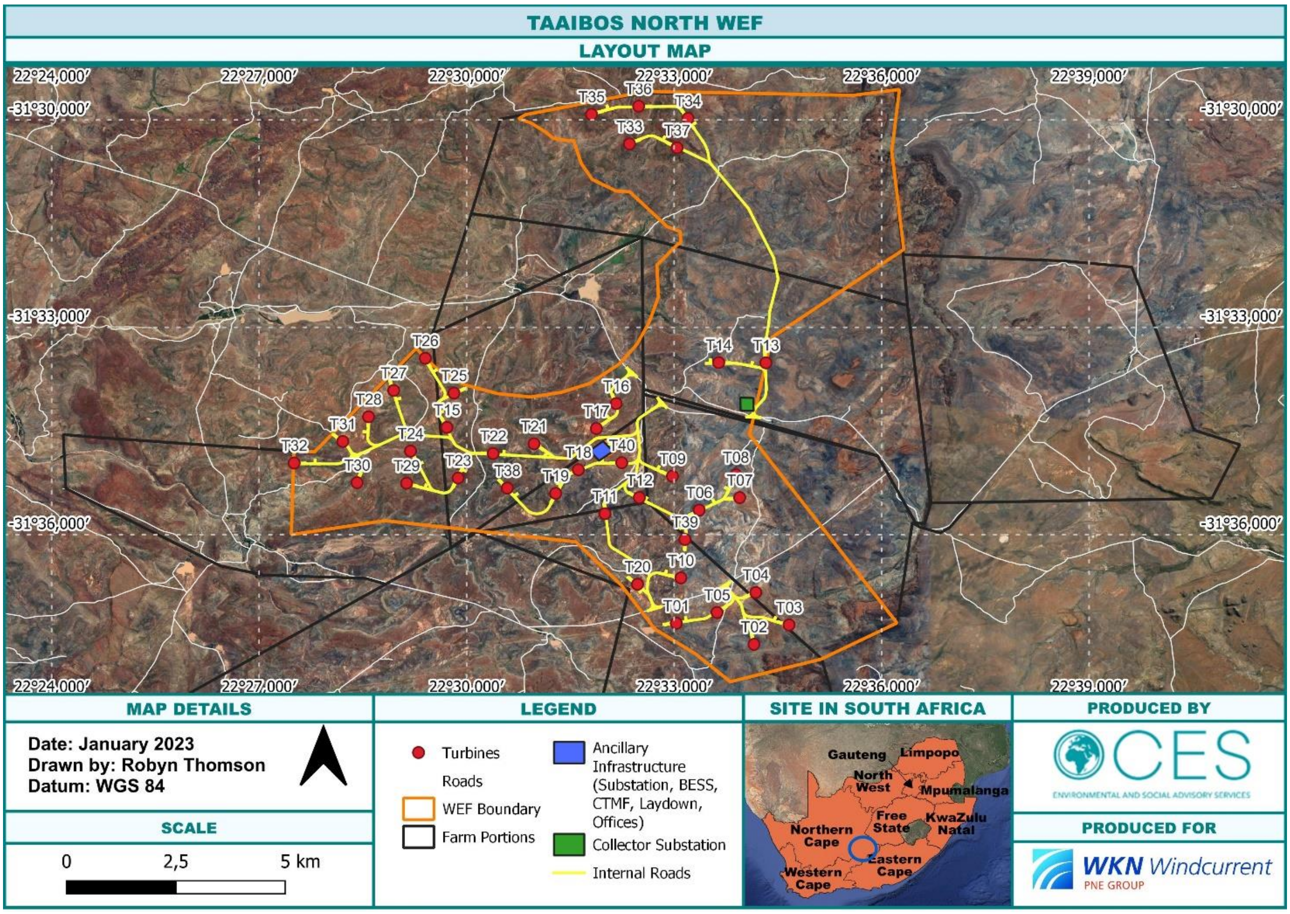

Figure above: Layout map of Taaibos North WEF

5. Taaibos South WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 36
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m
BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 **ha**	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 **ha**
Temporary Laydown Area	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 **ha**	TOTAL 0 m^2 x 36 turbines = 0m^2 which equates to 0 **ha**
Turbine Foundation	TOTAL Up to 900m^2 x 36 turbines = 32 400 m^2 which equates to 3**.24 ha**	TOTAL Up to 900m^2 x 36 turbines = 32 400 m^2 which equates to 3**.24 ha**
WEF Substation	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 36 000 m x 14m = 504 000 m^2 which equates to 50.4 **ha**	TOTAL (better estimate coming with civil layout) 36 000 m x 8m = 288 000 m^2 which equates to 28.8 **ha**
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 36 000 m x 14m = 504 000 m^2 which equates to 50.4 **ha**	TOTAL (better estimate coming with civil layout) 36 000 m x 8m = 288 000 m^2 which equates to 28.8 **ha**
TOTAL FOOTPRINT:	**138.64 ha *of clearing needed for the construction phase***	**84.64 ha *of clearing remaining during the post-construction operational phase***

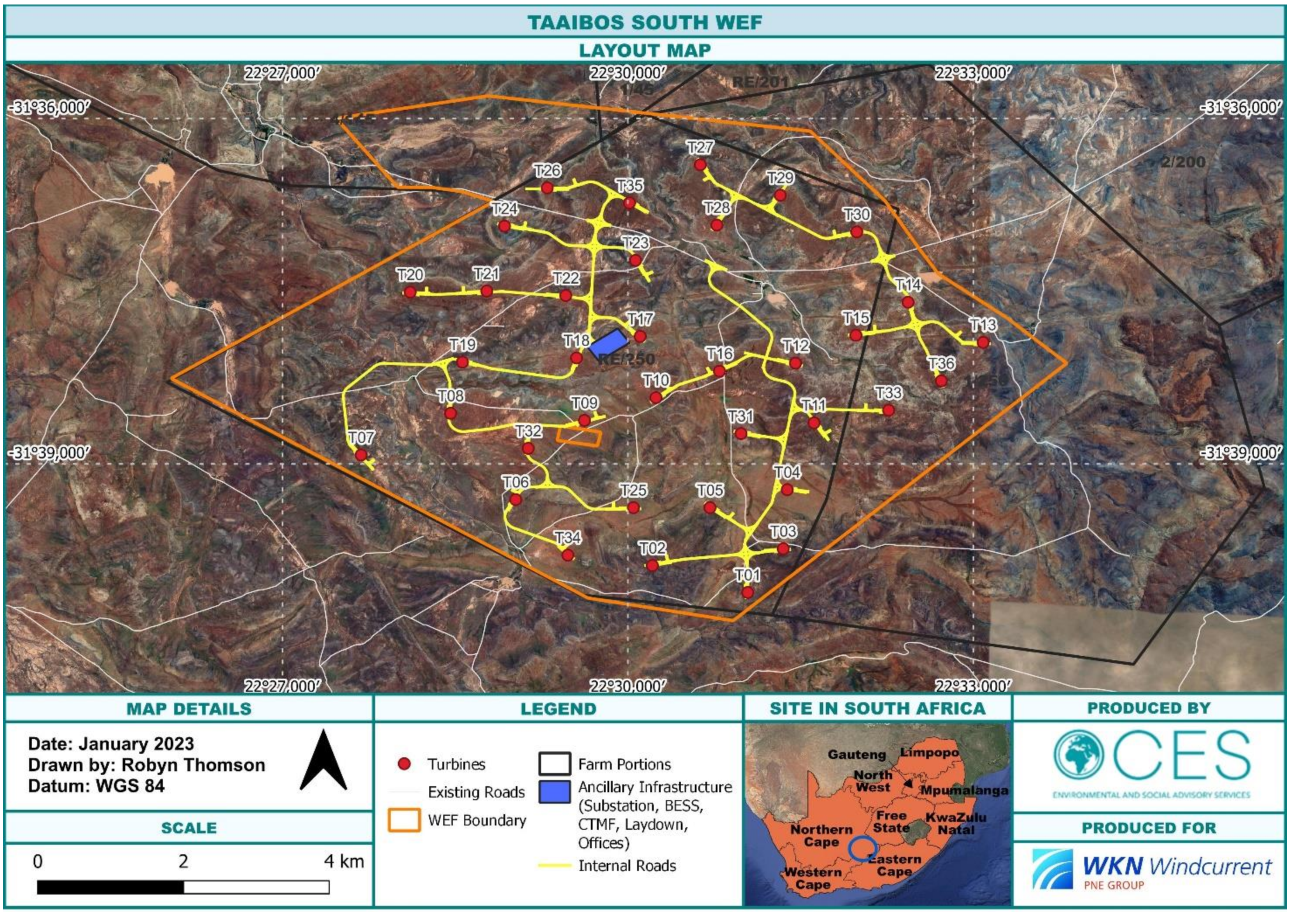

Figure above: Layout map of Taaibos South WEF