SiVEST SA (PTY) LTD

PROPOSED CONSTRUCTION OF THE KRAALTJIES WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE, NEAR BEAUFORT WEST, WESTERN CAPE PROVINCE, SOUTH AFRICA

Palaeontological Heritage Report

DFFE Reference: 14/12/16/3/3/2/2264
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Issue Date: **28 August 2023**
Version No.: **4**

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PALAEONTOLOGICAL HERITAGE REPORT

EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing to develop the Kraaltjies Wind Energy Facility (WEF) and associated Infrastructure on a site in the southern Great Karoo, located *c*. 50 to 60 km south of Beaufort West and *c*. 55 km west of Rietbron. The WEF will be situated on Portion 10 and Portion 25 of the Farm Brits Eigendom No 374 in the Beaufort West Local Municipality (Central Karoo District Municipality), Western Cape Province. The proposed Kraaltjies WEF will comprise up to twenty (20) wind turbines with a maximum total energy generation capacity of up to approximately 240MW. The electricity generated by the proposed WEF development will be fed into the national grid *via* a 132kV overhead power line which will connect the Kraaltjies WEF on-site substation to the national grid and is the subject of a separate Basic Assessment process.

The proposed Kraaltjies WEF and associated Infrastructure project area is underlain by continental (fluvial / lacustrine) sediments of the Abrahamskraal Formation and lowermost Teekloof Formation (Lower Beaufort Group, Karoo Supergroup) which are of late Middle Permian age. These bedrocks contain sparse, unpredictable to locally concentrated vertebrate fossils as well as rare trace fossils (*e.g.,* tetrapod trackways and burrows, lungfish burrows) and plant material of scientific and conservation value. Comparatively few new fossil vertebrate sites - most notably a partial, articulated skeleton of a therocephalian carnivore - have been recorded within the WEF project area during the short (3.5 day) site visit, while several more sites have previously been mapped in the vicinity during recent palaeontological surveys of adjoining WEF project areas. The few new palaeontological sites recorded, together with their sedimentological context, provide important data for on-going research into the pattern and causes of the Middle Permian Mass Extinction Event on land around 260 million years ago. All of the recorded fossil sites lie *outside* the WEF and associated Infrastructure project footprint.

Only one small palaeontological Very High Sensitivity area – located towards the southern edge of Farm Brits Eigendom No 374/25 and characterized by *in situ* therapsid skeletal material and abundant fish remains - has been identified within the project area (see red polygon, including a buffer zone, in satellite image Appendix 1, Figure A1.2). This High Sensitivity area lies *outside* the WEF and associated Infrastructure footprints. Since all known fossil sites can be readily mitigated – if necessary – through professional recording and collection of fossil material in the pre-construction phase, no

recommendations for micro-siting of infrastructure such as wind turbine, pylon positions or access roads are therefore made here. There are no preferences on palaeontological heritage grounds for specific site options for the WEF on-site substation BESS, O&M buildings, guard house and construction laydown area, given their similar geological and palaeontological context.

The proposed Kraaltjies WEF and associated Infrastructure developments are assigned a similar overall impact significance rating (Construction Phase) of NEGATIVE MEDIUM without mitigation and NEGATIVE LOW following mitigation. Residual negative impacts may be partially offset by improvements to the local palaeontological database as a result of professional mitigation of chance fossil finds.No significant further impacts on fossil heritage resources are anticipated in the planning, operational and decommissioning phases. The No-Go Option is likely to have a neutral impact significance; fossils will continue to be exposed and destroyed by natural weathering processes while the positive benefits of professional mitigation (*viz*. improved palaeontological database) will be lost. Anticipated cumulative impacts in the context of several planned or authorized renewable energy projects in the region are assessed as NEGATIVE MEDIUM before mitigation and NEGATIVE LOW after mitigation. These cumulative impacts fall within acceptable limits.

Recommended mitigation for the WEF and associated Infrastructure project comprises:
If (*and only if*) the WEF receives Environmental Authorization, the approved layout of the WEF and associated Infrastructure must be, immediately pre-construction, cross-checked by a qualified palaeontological specialist to determine what level of additional palaeontological surveying, monitoring or mitigation is necessary for these projects, if any. Should a palaeontological heritage study of selected, potentially sensitive and previously unsurveyed sectors of the authorised footprint be recommended at this stage, this should involve the recording and judicious collection by a professional palaeontologist of valuable fossil material as well as relevant geological data (e.g., on stratigraphic context, preservation style / taphonomy) within or close to (within ~10 m) the project footprint in the Pre-Construction Phase. Since mitigation through professional recording and collection is almost invariably feasible for fossil sites. During the construction phase, the Chance Fossil Finds Protocol summarised in Appendix 2 should be fully implemented.

The qualified palaeontologist responsible for any Construction Phase mitigation work will need to submit beforehand a Work Plan for approval by Heritage Western Cape (HWC) and, following completion of mitigation, a Mitigation Report must be submitted by the specialist to HWC for consideration.

The proposed WEF and associated Infrastructure development is not fatally flawed and, on condition that the recommended mitigation measures are included within the relevant EMPr and implemented in full, there are no objections on palaeontological heritage grounds to the granting of Environmental Authorisation for the Kraaltjies WEF project.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	**1.2** **Appendix 3**
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Appendix 5**
c) an indication of the scope of, and the purpose for which, the report was prepared;	**1.1** **Appendix 4**
(cA) an indication of the quality and age of base data used for the specialist report;	**1.3.1**
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	**6**
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**1.3.1**
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	**1.3**
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	**6**
g) an identification of any areas to be avoided, including buffers;	**n/a**
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	**Appendix 1**
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**2**
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	**5.2, 6.4, 7, 9.1**
k) any mitigation measures for inclusion in the EMPr;	**9.1** **Appendix 2**
l) any conditions for inclusion in the environmental authorisation;	**9.1**
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**9.1**
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	**9**
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	**1.3.1**
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	**n/a**
q) any other information requested by the competent authority.	**n/a**
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	**n/a**

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PALAEONTOLOGICAL HERITAGE REPORTRT

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List of Abbreviations

amsl	above mean sea level
DFFE	Department of Forestry, Fisheries and the Environment
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
HWC	Heritage Western Cape
Ma	millions of years ago
PIA	palaeontological heritage impact assessment
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
WEF	Wind Energy Facility

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PALAEONTOLOGICAL HERITAGE REPORT

1. INTRODUCTION

South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as "Mainstream"), has appointed SiVEST SA (Pty) Ltd (hereafter referred to as "SiVEST") to undertake the required EIA Process for the proposed construction of the up to 240MW Kraaltjies Wind Energy Facility (WEF) and separate Basic Assessment Process for the associated grid connection infrastructure near Beaufort West in the Western Cape Province. The overall objective of the development is to generate electricity by means of renewable energy technology capturing wind energy to feed into the National Grid.

It is anticipated that the proposed Kraaltjies WEF will comprise of up to twenty (20) wind turbines with a maximum total energy generation capacity of up to approximately 240MW. The electricity generated by the proposed WEF development will be fed into the national grid *via* a 132kV overhead power line which is to be separately assessed.

In terms of the Environmental Impact Assessment (EIA) Regulations, which were published on 04 December 2014 [GNR 982, 983, 984 and 985) and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department of Environment, Forestry and Fisheries (DFFE), prior to the commencement of such activities. Specialist studies have been commissioned to assess and verify the project under the new Gazetted specialist protocols.

1.1 Terms of Reference

The present combined desktop and field-based PIA report assesses potential impacts to palaeontological heritage resources that may result from the proposed Kraaltjies WEF and its associated infrastructure. It will contribute to the over-arching Heritage Impact Assessment, co-ordinated by PGS Heritage and SiVEST Environmental Division, as part of the Environmental Impact Assessment process for this development as well as to the relevant EMPr.

1.2 Specialist Credentials

The author, Dr John Almond, is a specialist palaeontologist who has over 40 years of experience in palaeontological research and teaching in Europe, South Africa and elsewhere. He also has more than 20 years of experience in the palaeontological heritage impact assessment sector in the RSA and has been involved with numerous PIAs in the Karoo region and elsewhere (Please see Appendix 1 for a short Specialist CV).

1.3 Assessment Methodology

1.3.1 Information sources

The desktop and field-based palaeontological heritage study of the Kraaltjies WEF and associated Infrastructure project areas was based on the following information resources:

1. A detailed project outline, kmz files, screening report and maps provided by SiVEST Environmental Division and PGS Heritage;

2. A desktop review of:
   (a) the relevant 1:50 000 scale topographic map (3222DC Amandelhoogte) as well as the 1:250 000 scale topographic map 3222 Beaufort West),
   (b) Google Earth© satellite imagery,
   (c) published geological and palaeontological literature, including 1:250 000 geological map (3222 Beaufort West) and relevant geological sheet explanation (Johnson & Keyser 1979) as well as
   (d) several previous and on-going fossil heritage (PIA) assessments in the Great Karoo region to the south of Beaufort West by the author listed in the References (especially Almond 2018, 2022d);

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

4. A three and a half-day field assessment of the Kraaltjies WEF project area, including portions of all land parcels involved, by the author and two experienced field assistants (Ms Madelon Tusenius, *Natura Viva* cc and Ms Hedi Stummer, previously of Iziko Museums, Cape Town), during the period 5-7 and 9 November 2020. Subsequent to the original fieldwork within the Kraaltjies WEF project area, a short palaeontological visit (17 March 2022) to review and collect fossil finds was made by the author in the company of Professor Bruce Rubidge and Dr Marc van den Brandt of Wits University, Johannesburg. Two further palaeontological field studies were also undertaken in the adjoining Beaufort West WEF and Trakas WEF project areas which are of relevance to the Kraaltjies WEF project (*cf* Almond 2018 and 2022d). The season in which the site visit took place has no critical bearing on the palaeontological study,

although palaeontological fieldwork in the Karoo winter was somewhat hampered by shorter days, occasional rain and low-angle light, making fossils more difficult to discern and to photograph effectively.

1.3.2 Study approach

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 Western Cape have already been compiled by J. Almond and colleagues; *e.g.* 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.

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. It is occasional practice for impact palaeontologists to collect representative, well-localised (*e.g.* GPS and stratigraphic data) samples of fossil material during field assessment studies. In order to do so, a fossil collection permit from Heritage Western Cape (HWC) is required and all fossil material collected must be properly curated within an approved repository (usually a museum or university collection).

Note that while fossil localities recorded during fieldwork 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.

Given 1) the large project areas concerned with the Kraaltjies WEF and associated Infrastructure project and (2) the extensive bedrock exposure in this region of the Great Karoo, the palaeontological heritage field study largely entailed the examination of selected potentially fossiliferous sites with good Beaufort Group mudrock exposure – especially along drainage lines as well as gentler hillslopes and erosion gullies. Since previous field experience shows that in the lower part of the Beaufort Group outcrop area important fossil sites may also occur in association with crevasse splay and channel sandstones, a representative selection of such sites as well as good sections through Late Caenozoic alluvial deposits were also examined. It is emphasised that it is simply *not* practicable to record all, or even a major portion, of fossil sites within such a large area within the course of a few days' fieldwork, and that the occurrence of fossils at surface in the Great Karoo has a large element of unpredictability. Several fossil sites were discovered simply by chance. It is therefore inevitable that the recent site visit can only hope to locate a *representative subsample* of surface fossil sites present within the WEF project area. The absence of recorded sites within an area does *not* therefore mean that palaeontologically significant material is not present there, either on or beneath the ground surface.

2. 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 these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.
3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information;
4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (e.g., of commercial mining companies) - that is not readily available for desktop studies;

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

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:
(a) underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
(b) overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc.).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails inferring the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist. In the present case, site visits to the various loop and borrow pit study areas in some cases considerably modified our understanding of the rock units (and hence potential fossil heritage) represented there.

In the case of the present study area in the southern Great Karoo region due south of Beaufort West (Western Cape) exposure of potentially fossiliferous bedrocks is very limited, due to extensive cover by superficial sediments and karroid *bossieveld* vegetation. However, sufficient exposures were examined to allow a realistic assessment of the palaeontological sensitivity of the key rock units (See Appendix 1), while a substantial amount of relevant geological and palaeontological data is available from previous PIAs in the region (See, for example, References under Almond and Appendix 1). Confidence levels for this assessment are rated accordingly as Medium. Comparatively few academic palaeontological studies have been carried out in the region so any new data from impact studies here are of scientific interest (*cf* an ongoing research project on late Middle Permian fossil assemblages in the Main Karoo Basin by Professor Bruce Rubidge at Wits University and colleagues).

3. TECHNICAL DESCRIPTION

3.1 Project Location

The proposed Kraaltjies WEF and associated Infrastructure is located 60km south of Beaufort West in the Western Cape Province and is within the Beaufort West Local Municipality, in the Central Karoo District Municipality (**Figure *1***).

Figure 1: Regional Context Map for the Kraaltjies WEF project area situated 60 km south of Beaufort West, Western Cape Province

3.1.1 WEF

The WEF application site as shown on the locality map below (**Figure *2***) is approximately 3994.9 hectares (ha) in extent and incorporates the following farm portions:

- Portion 10 of the Farm Brits Eigendom No 374; and
- Portion 25 of the Farm Brits Eigendom No 374.

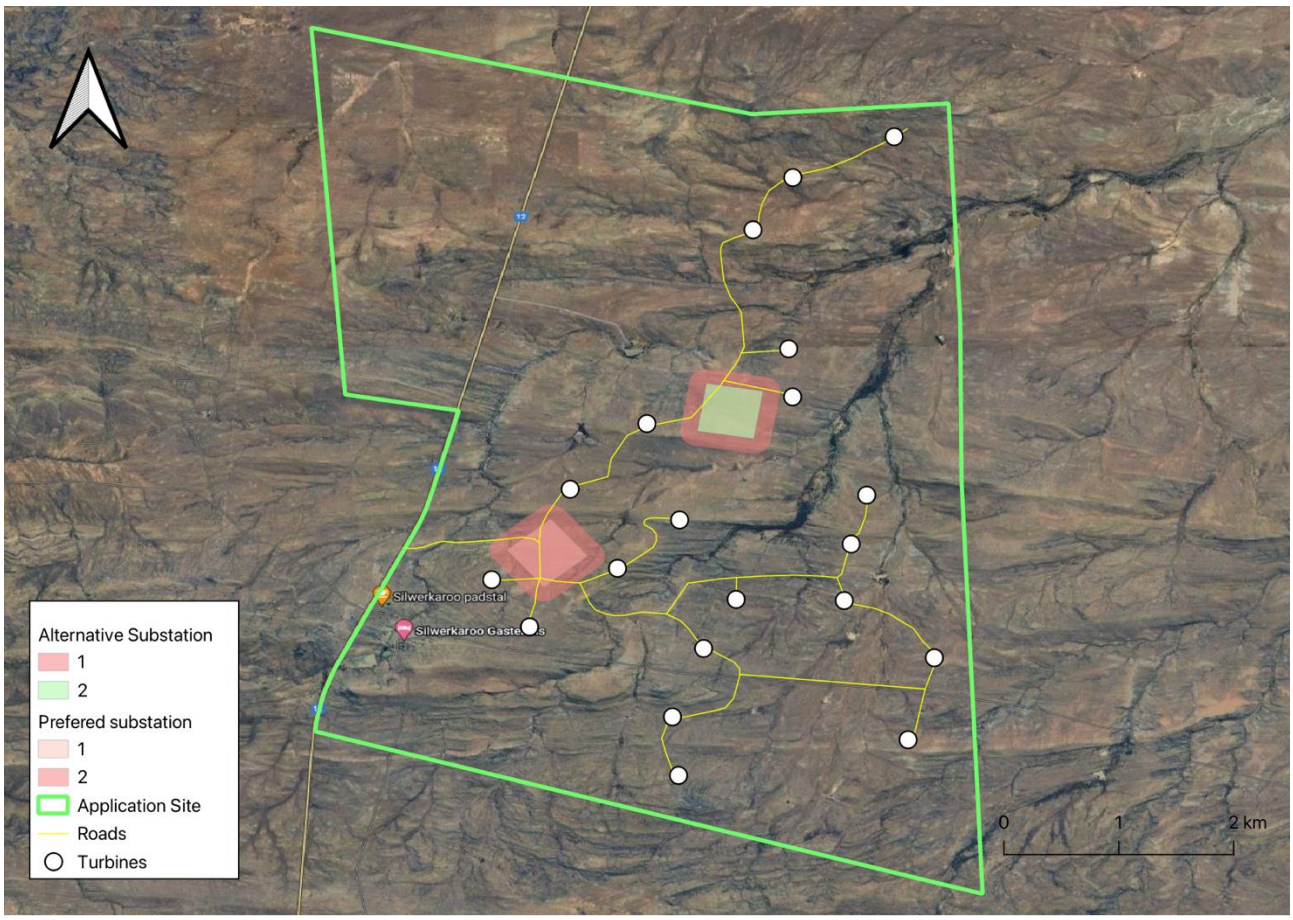

Figure 2: Kraaltjies WEF Site Locality

3.2 Project Description

It is anticipated that the proposed Kraaltjies WEF will comprise of maximum of up to twenty (20) wind turbines with a maximum total energy generation capacity of up to approximately 240MW. The electricity generated by the proposed WEF development will be fed into the national grid *via* a 132kV overhead power line. The 132kV overhead power line and associated Eskom Switching Station will however require a separate EA subject to a separate BA process (not assessed herein), which is currently being undertaken in parallel to this EIA process.

3.2.1 Wind Farm Components

- Up to twenty (20) wind turbines, with a maximum export capacity of approximately 240MW. This will be subject to allowable limits in terms of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The final number of turbines and layout of the WEF will, however, be dependent on the outcome of the Specialist Studies conducted during the EIA process.
- Each wind turbine will have a hub height of up to 120m to 200m and rotor diameter of up to approximately 200m.

- Permanent compacted hardstand areas / platforms (also known as crane pads) of approximately 90m x 50m (total footprint of approx. 4 500m^2) per turbine during construction and for on-going maintenance purposes for the lifetime of the proposed development.
- Each wind turbine will consist of a foundation of up to approximately 15m x 15m in diameter. In addition, the foundations will be up to approximately 3m in depth.
- Electrical transformers (690V/33kV) adjacent to each wind turbine (typical footprint of up to approximately 2m x 2m) to step up the voltage to 11-33kV.
- Associated infrastructure of approximately 25ha which includes:
    - One (1) new 11-33kV/132kV IPP on-site substation including associated equipment and infrastructure the proposed substation will be a step-up substation and will include an Eskom portion and an IPP portion, hence the substation has been included in the WEF EIA and in the grid infrastructure (substation and 132kV overhead power line) BA to allow for handover to Eskom. Following construction, the substation will be owned and managed by Eskom.
    - A Battery Energy Storage System (BESS) will be located next to the onsite 11-33kV/132kV substation. The storage capacity and type of technology would be determined at a later stage during the development phase, but most likely comprise an array of containers, outdoor cabinets and/or storage tanks.
    - One (1) construction laydown / staging area up to 3ha. It should be noted that no construction camps will be required in order to house workers overnight as all workers will be accommodated in the nearby town.
    - Operation and Maintenance (O&M) buildings, including offices, a guard house, operational control centre, O&M area / warehouse / workshop and ablution facilities to be located on the site identified for the substation.
- The wind turbines will be connected to the proposed substation via medium voltage (11-33kV) underground cabling and overhead power lines.
- Road servitude of 8m and a 20m underground cable or overhead line servitude.
- Internal roads with servitude up to approximately 8m wide will provide access to each wind turbine. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary. Turns will have a radius of up to 50m for abnormal loads (especially turbine blades) to access the various wind turbine positions. It should be noted that the proposed application site will be accessed via the N12 National Route. During operation, internal roads with a width of up to approximately 5m (excluding reserves) wide will provide access to each wind turbine. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary.
- A wind measuring lattice (approximately 140m in height) mast has already been strategically placed within the wind farm application site in order to collect data on wind conditions.
- No new fencing is envisaged at this stage. Current fencing is standard farm fence approximately 1-1.5m in height. Fencing might be upgraded (if required) to be up to approximately 2m in height; and
- Water will either be sourced from existing boreholes located within the application site or will be trucked in, should the boreholes located within the application site be limited.

3.3 Alternatives

3.3.1 Wind Energy Facility

No other activity alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view and a wind energy facility is considered suitable for this site due to the high wind resource in this area.

The choice of technology selected for the Kraaltjies WEF is based on environmental constraints and technical and economic considerations. No other technology alternatives are being considered as wind energy facilities are more suitable for the site than other forms of renewable energy due to the high wind resource.

The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The choice of turbine to be used will ultimately be determined by technological and economic factors at a later stage.

Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations also including for the on-site substation (Eskom and IPP portions), construction laydown area, BESS and O&M buildings. The proposed layout is shown in Figure 3 below.

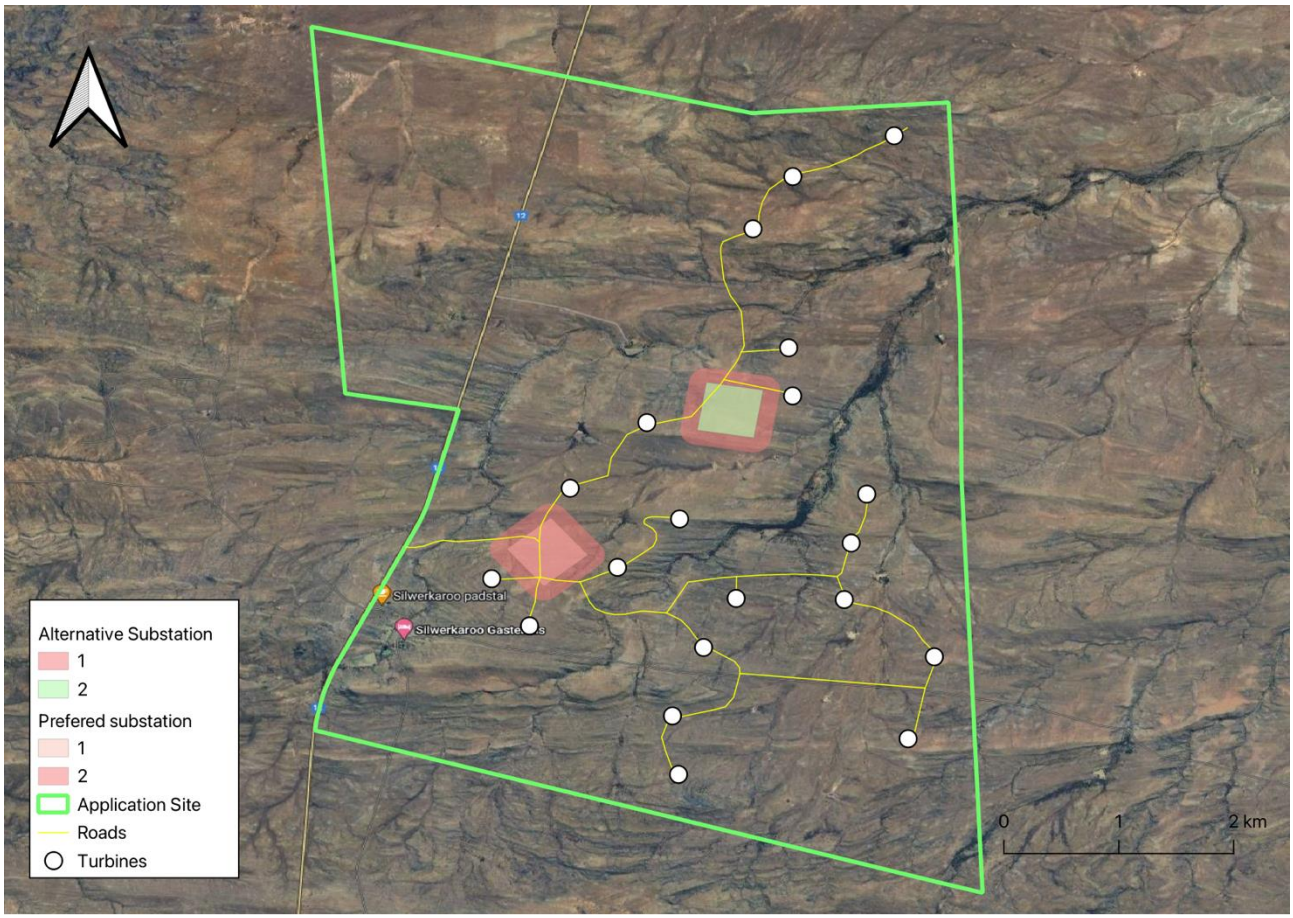

Figure 3: Proposed layout for the Kraaltjies WEF

3.3.2 No-go Alternative

The 'no-go' alternative is the option of not undertaking the proposed WEF and associated Infrastructure project. Hence, if the 'no-go' option is implemented, there would be no development. This alternative would result in no environmental impacts from the proposed project on the site or surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

4. LEGAL REQUIREMENT AND GUIDELINES

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

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

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

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

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

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

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

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

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

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

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

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

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and

where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013) and by Heritage Western Cape (2021).

5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

This section of the PIA report presents a short, illustrated overview of the geology and palaeontological heritage encountered within the Kraaltjies WEF and associated infrastructure project area. It also draws on relevant geological and palaeontological observations from the adjoining Beaufort West WEF and Trakas WEF project areas (Almond 2018, 2022d).

5.1 Geological context

A short outline of the geology of the Kraaltjies WEF project area (including the associated infrastructure project area) is provided in this section of the report as context for the palaeontological heritage data discussed in the

following subsection. The Kraaltjies WEF project area (**Figure 4** to **Figure 8** &

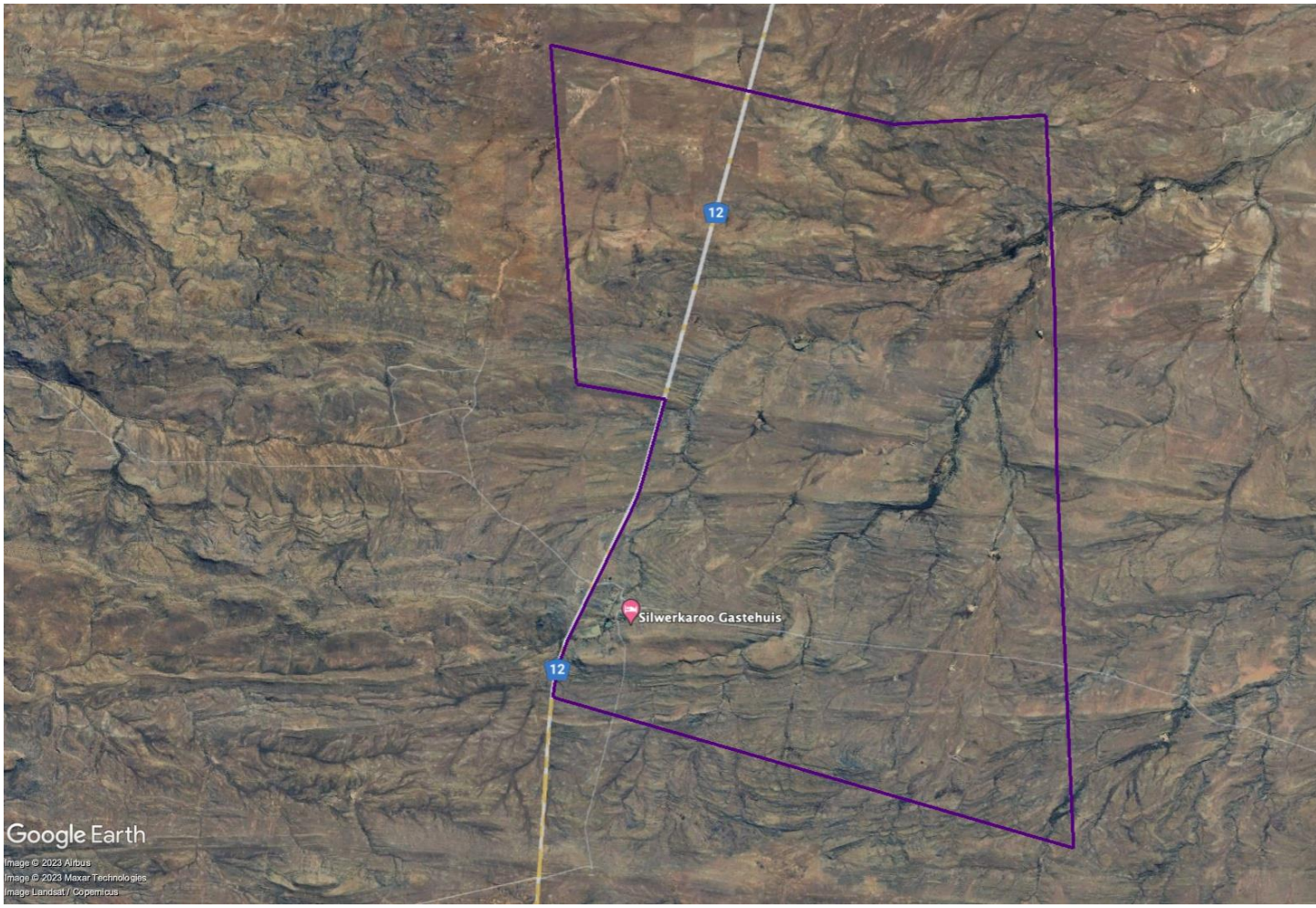

Figure *42*) is situated in semi-arid, gently hilly to flat-lying terrain at elevations between *c*. 1000 and 1060 m amsl on the southern margins of the Great Karoo region. It is transected by the Seekoegat - N12 – Rietbron minor road, road cuttings along which include good sections through the Karoo bedrocks and lies only ~40 km north of the Droëkloofberge which represent a northern outlier of the Cape Fold Mountains. The vegetation is dominated by semi-arid karroid *bossieveld* with small trees in riverine areas and taller woody shrubs (bush clumps) on sparsely scattered *heuweltjies* (see below).

Topographic relief within the project area is comparatively low compared to many of the regions of the Great Karoo since it lies on the SW periphery of the Aberdeen *Vlaktes*, interpreted by some authors as a possible relict of a Miocene African Land Surface (*cf* Partridge & Maud 1987, Watkeys 1999). Consequently, the Palaeozoic bedrocks in the study area are, for the most part, poorly exposed away from the more important drainage lines and occasional steeper hillslopes while near-surface mudrocks may display evidence of protracted chemical weathering beneath an ancient land surface (**Figure 15**). The area lies to the north of a regional watershed or drainage divide with drainage towards the northeast *via* the Amosrivier and Dourivier and their tributaries.

The geology of the Kraaltjies WEF project area is covered by 1: 250 000 geology sheet 3222 Beaufort West (Council for Geoscience, Pretoria; Johnson & Keyser 1979) (**Figure 10**). Most of the lower-lying terrain within

the WEF project area is underlain at depth by Middle Permian continental (fluvial / lacustrine) sediments of the **Abrahamskraal Formation** (Lower Beaufort Group / Adelaide Subgroup, Karoo Supergroup) (Pa, pale green in **Figure 10**) (Johnson & Keyser 1979). It is likely that the majority of these older bedrocks can be largely or entirely assigned to the sandstone package of the **Moordenaars Member** and the following mudrock-dominated **Karelskraal Member** towards the top of the very thick Abrahamskraal Formation succession (see stratigraphic columns in **Figure 9** and **Figure 11**). Abrahamskraal Formation channel sandstone packages here tend to be tabular to broadly lenticular in geometry, tabular-bedded, fine- to medium-grained and with sharp but not markedly gullied basal contacts with only infrequent development of breccio-conglomerates. The predominantly grey-green or grey (but occasionally purple-brown) overbank mudrocks contain frequent horizons of sizeable ferruginous carbonate concretions marking arid-climate palaeoesol (ancient soil) horizons. Contrasting episodes of aridity as well as major lake formation during more pluvial intervals on the floodplain is attested by desiccation cracks (infilled with sand or gypsum), horizons packed with silicified pseudomorphs of gypsum roses, wave-rippled sandstone bed tops as well as thin beds with abundant disarticulated fish remains and rare lungfish burrow casts (Section 5.2). Distinctive, laterally persistent horizons of greenish-grey, siliceous, fine-grained tuffite (ash intermixed with terrigenous sediment) reflect increased volcanism close to the Abrahamskraal Formation – Poortjie Member boundary.

The east-west trending ridges of higher ground in the southern, central and northern sectors of the WEF project area are underlain by the more resistant-weathering, sandstone-dominated packages – with minor mudrock intervals - of the **Poortjie Member** (**Teekloof Formation**) (Lower Beaufort Group / Adelaide Subgroup) (Pt, dark green in **Figure 10**), of latest Middle Permian to earliest Late Permian age. The Poortjie Member channel sandstone bodies are often “golden yellow” in hue with a distinctive friable, medium-grained texture, a tabular geometry and bedding style.

Given the complexity of Cape-age folding and thrust faulting in the study region, no attempt has been made here to identify the member-level stratigraphy in the project area. This includes defining the local boundary between the Abrahamskraal and Teekloof Formations, for which detailed mapping beyond the scope of the present study would be required; the scheme shown in the published geological map is provisionally followed. The sedimentology of the Abrahamskraal Formation has been reviewed recently by Wilson *et al.* (2014) while the Abrahamskraal – Teekloof transition has been addressed by Paiva (2015).

Figure 4: Footslopes of the Sofkraal se Koppe ridge on the northern margins of Farm Brits Eigendom No 374/10 showing dark mudrocks of the uppermost Abrahamskraal Formation capped by the pale yellowish-brown Poortjie Member sandstone package at the base of the Teekloof Formation.

Figure 5: Low relief, planed-off terrain on the eastern sector of Farm Brits Eigendom No 374/25 showing low, projecting ridges of dipping Beaufort Group sandstones in the foreground and a pervasive mantle of blocky eluvial surface gravels and sand.

Figure 6: View northwards into the Kraaltjies WEF project area from the Poortjie Member ridge towards the southern edge of Farm Brits Eigendom No 374/25 showing the general low relief, semi-arid terrain related to a relict post-African erosion surface of Late Caenozoic age.

Figure 7: Shallow incised valley of the N-flowing Dourivier on Farm Brits Eigendom No 374/25 with low ridges of Abrahamskraal Formation channel sandstones but limited overbank mudrock exposure.

Figure 8: Higher relief, dissected terrain in the SW sector of Farm Brits Eigendom No 374/25 showing dark Abrahamskraal Formation mudrocks in the foreground and middle distance with uplands of Poortjie Member sandstones on the skyline to the northeast.

Early Jurassic intrusions of the **Karoo Dolerite Suite** are not mapped within the project area but do occur closer to Beaufort West. The project area lies within the northern margins of the Cape Fold Belt where levels of tectonic deformation vary from low to moderately high. As is clearly apparent from the striking colour-striped

patterns seen on satellite images (

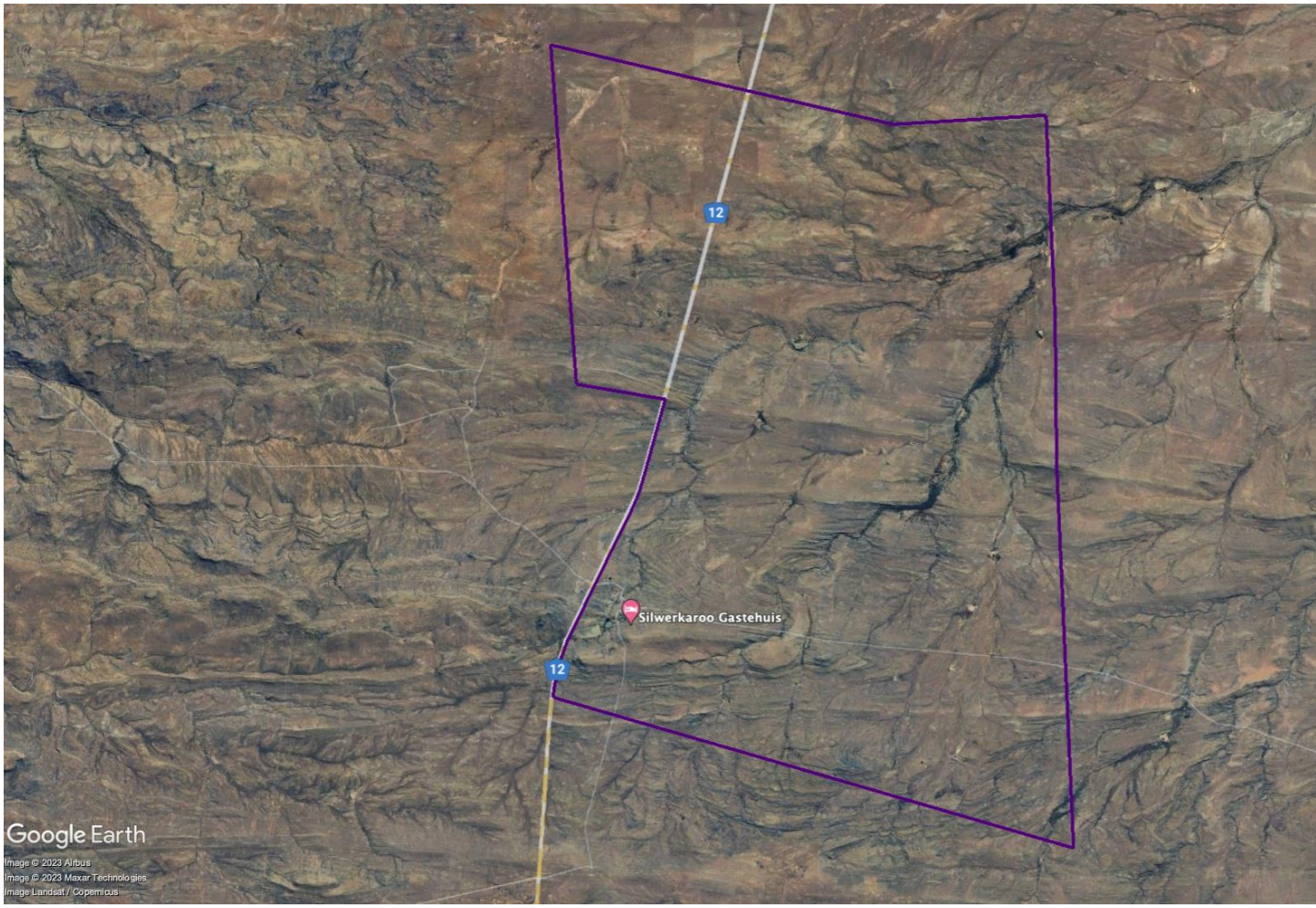

Figure *42*) as well as in the field, the Palaeozoic bedrocks here have been deformed by moderately intense, north-directed crustal compression during the Permo-Triassic Orogeny, resulting in a series of tight, large-scale folds with broadly W-E trending axes as well as several low-angle thrust faults with a similar strike orientation in the region. The latter are often associated with quartz veining as well as mylonitic crush breccias and are well seen in road cuttings along the N12 (**Figure 41**). Mapped bedding dips are up to 25º and both mudrock as well as sandstone facies may be affected by a pervasive cleavage or closely-spaced fracture sets with a broadly west-east orientation.

The Palaeozoic bedrocks in the study area are, for the most part, poorly exposed away from the more important drainage lines and occasional steeper hillslopes. Topographic relief is generally low so that on gentler hillslopes, beneath the extensive gravelly to sandy *vlaktes,* as well as along many water courses the bedrocks are mantled by a spectrum of **Late Caenozoic superficial sediments**. For the most part these comprise downwasted (eluvial) surface gravels (notably of wacke / vein quartz and tuffite), rubbly colluvium, silty, sandy and gravelly alluvium and skeletal soils with local development of spring deposits such as calcrete.

Most of the superficial deposits are unconsolidated and probably of Late Pleistocene to Holocene age (*i.e., deposited* within the last 2.5 million years) but some alluvium is well-calcretised and might be somewhat older. High Level gravel terraces are not well-developed in the region, implying low levels of stream incision, and

there are no extensive areas of alluvium within the WEF and associated infrastructure project area on the geological map (these are better represented along the Amosrivier and Dourivier on the 1: 50 000 topographic sheets).

An interesting surface feature of the region are well-developed *heuweltjies* or mima mounds – slightly raised areas up to 10 or so meters in diameter that are characterised by pale, calcretised sandy soils, tall woody shrubs or small trees, and intensive vertebrate burrowing as well as frequently by Later Stone Age artefacts. These relictual to currently active features show up as well-dispersed, pale, round spots on aerial photos and satellite images and have been variously attributed to a combination of termite activity, mammalian burrowing and bush clumps.

The main geological features of this region of the Great Karoo margins have already been covered in some detail in the previous accounts of the adjoining Trakas and Beaufort West WEFs by Almond (2018, 2022d, 2022e) and will therefore not be repeated at length here. Selected examples of key geological features within the Kraaltjies WEF project area are illustrated below (**Figure 12** to **Figure 41**), with explanatory figure legends, while satellite maps of the principal fossil localities located during the palaeontological field survey is provided in Appendix 1.

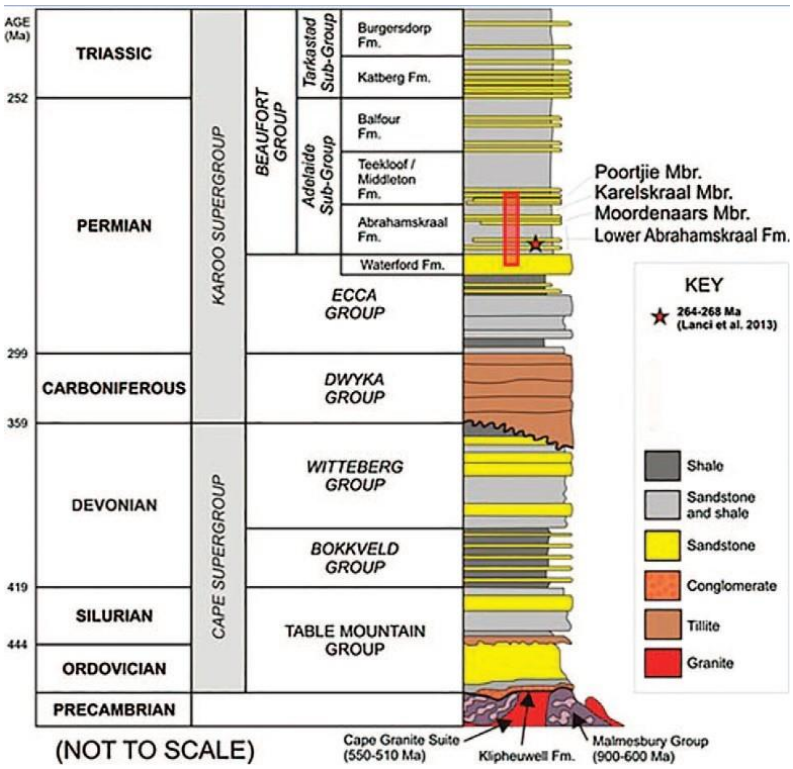

Figure 9: Palaeozoic stratigraphic column for the Western Cape showing the position of the Abrahamskraal and Teekloof Formations of the Lower Beaufort Group within the Karoo Supergroup. A Middle Permian (Wordian) zircon age has been obtained for the lower part of the Abrahamskraal Formation (red star) (Figure modified from Wilson *et al.* 2014). The base of the Poortjie Member has recently been dated to 260 Ma (end-Capitanian = end Middle Permian) on the basis of a white tuff unit 3.5 m above the basal sandstone (Day *et al.* 2015b). As currently mapped, only the Abrahamskraal Formation and Poortjie Member (basal Teekloof Formation) are represented within the Kraaltjies WEF / Grid Connection Infrastructure project area but this may be revised with further detailed mapping.

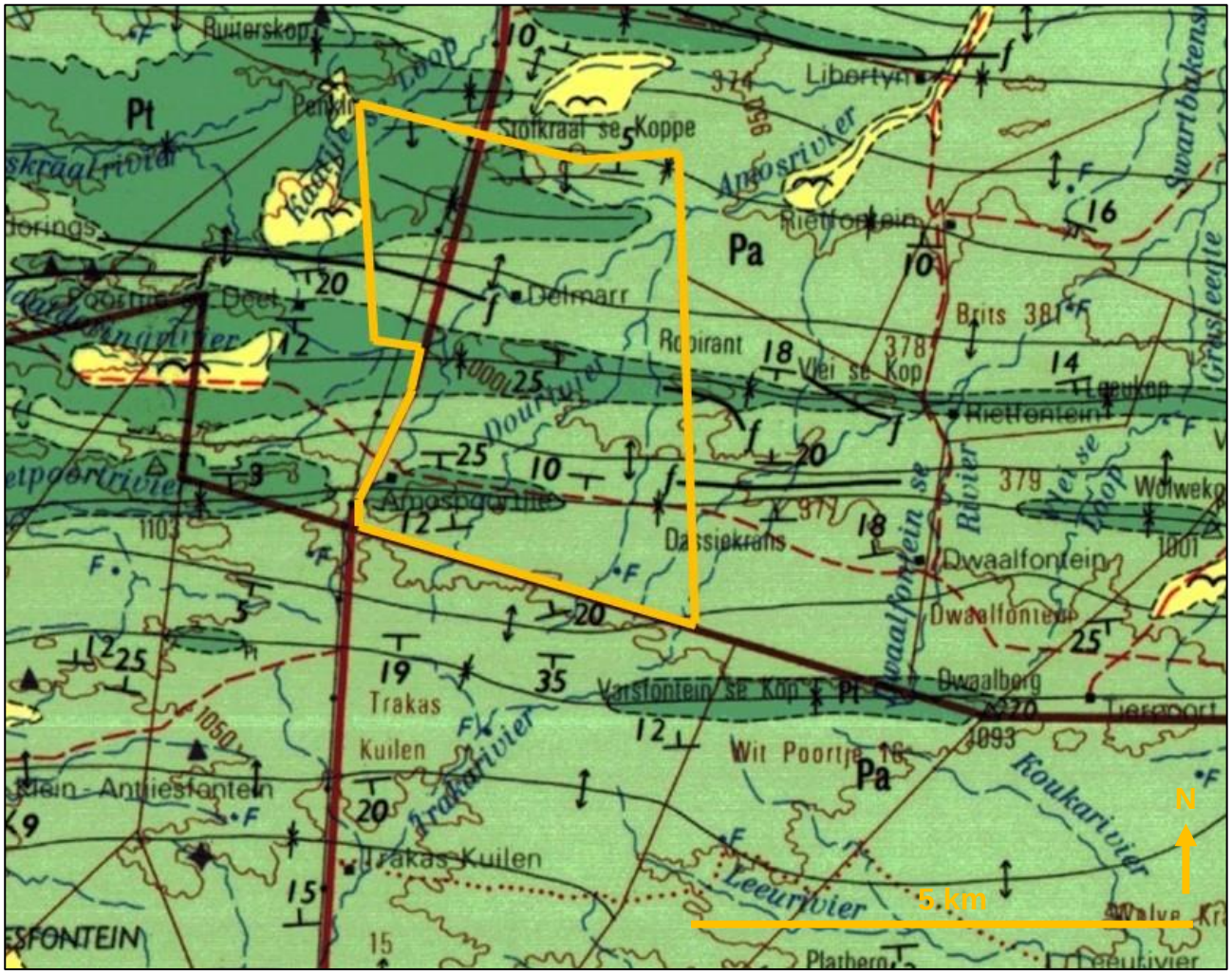

Figure 10: Extract from 1: 250 000 geology sheet 3222 Beaufort West showing the boundaries of the Kraaltjies WEF project area to the south of Beaufort West (orange polygon). Note numerous W-E trending fold axes occur in the region which falls within the northern margins of the Cape Fold Belt. Pa (pale green) = Abrahamskraal Formation (Adelaide Subgroup, Lower Beaufort Group). Pt (dark green) = Poortjie Member of the Teekloof Formation (Adelaide Subgroup, Lower Beaufort Group). Yellow = Late Caenozoic / Quaternary superficial sediments, including alluvium (flying bird symbol), as well as unmapped sheet wash, colluvium, soils, locally cemented by pedocretes such as calcrete. To the west of the N12 and outside the WEF and associated Infrastructure project area diamond symbols indicate fossil localities within the *Tapinocephalus* Assemblage Zone. Triangles indicate fossils within the *Pristerognathus* Assemblage Zone (*N.B*. This fossil biozone data is now outdated and the fossils concerned have probably been collected).

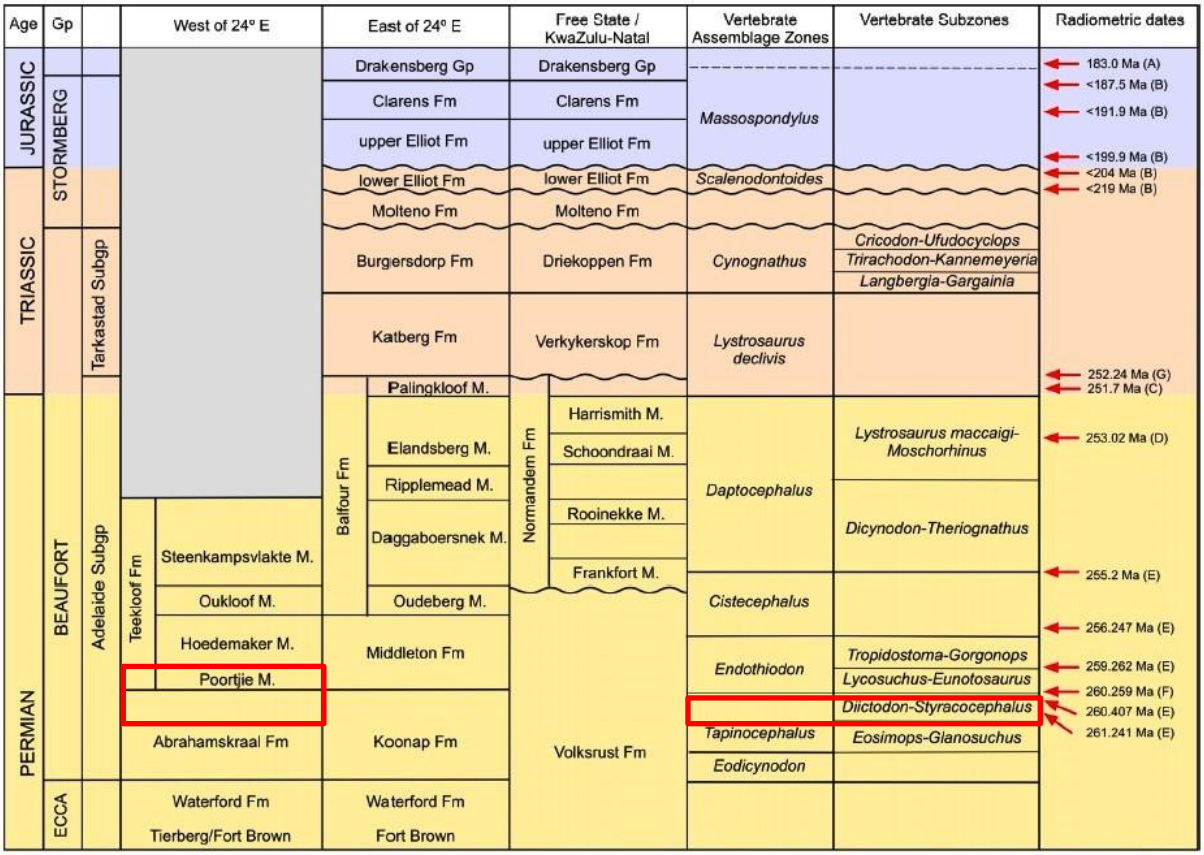

Figure 11: Chart showing the latest, revised fossil biozonation of the Lower Beaufort Group of the Main Karoo Basin (abstracted from Smith *et al.* 2020). Rock units and fossil assemblage zones mapped within the Kraaltjies WEF and associated Infrastructure project area are outlined in red respectively. The detailed mapping of these lithostratigraphic and biostratigraphic units within the present project area is unresolved at present.

Figure 12: Erosive-based channel sandstone body of the Abrahamskraal Formation sharply overlying thin-bedded grey-green overbank mudrocks with a well-defined, intermittent horizon of substantial ferruginous carbonate concretions (arrowed), banks of the Dourivier on Farm Brits Eigendom No 374/25.

Figure 13: Weathering-out horizon of palaeocalcrete concretions marking an ancient soil horizon within grey-green overbank mudocks, Abrahamskraal Formation on Farm Brits Eigendom No 374/25 (hammer = 30 cm).

Figure 14: Weathered-out calcrete pedocrete horizon within purple-brown Abrahamskraal Formation mudrocks on the western portion of Farm Brits Eigendom No 374/10 (hammer = 30 cm). Such horizons are a primary focus for fossil recording within the Lower Beaufort Group.

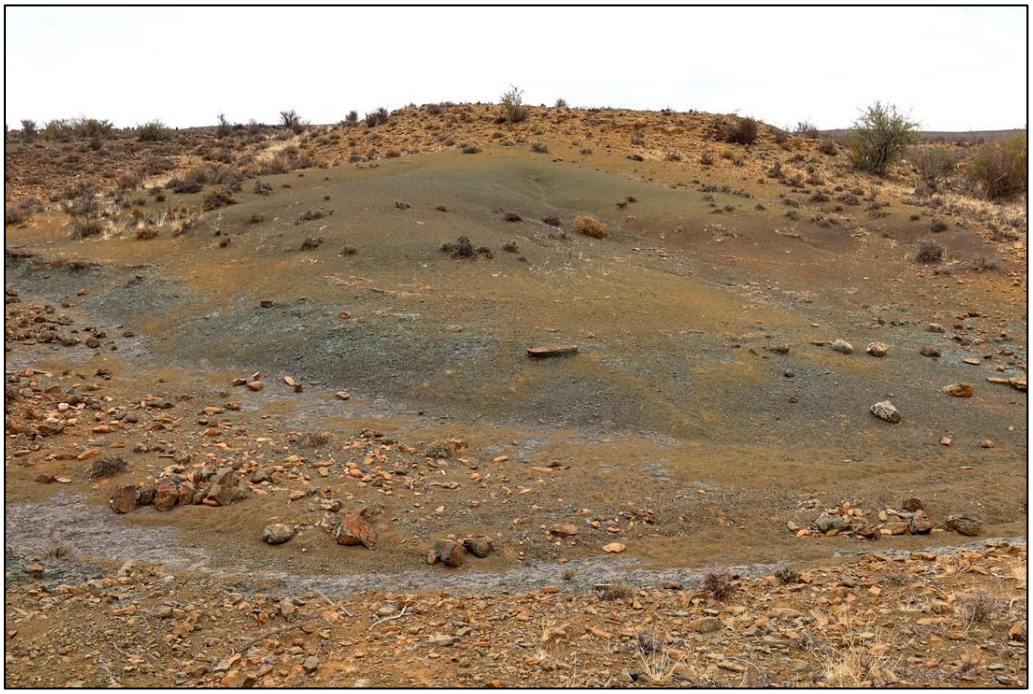

Figure 15: Gentle slopes of grey-green and purple-brown Abrahamskraal Formation mudrocks on Farm Brits Eigendom No 374/25. Such terrain is a primary target for palaeontological recording, although the bedrocks in this case are rather weathered.

Figure 16: Excellent hillslope and low kranz exposures of dark grey Abrahamskraal Formation mudrocks close to the southern boundary of Farm Brits Eigendom No 374/25. The bedrocks here show a pronounced, subvertical spaced cleavage of tectonic origin but have nevertheless yielded several important vertebrate and fish fossil remains.

Figure 17: Horizon of pronounced loading within the mudrock exposure illustrated above, caused by gravitational collapse of thin sandstone beds into underlying soupy muds within a sizable floodplain pond or lake (hammer = 30 cm).

Figure 18: Sphaeroidal silica pseudomorphs of desert roses showing radial configuration of the original gypsum crystals internally (scale = 15 cm). These fossil desert roses may locally dominate surface gravels overlying Abrahamskraal Formation mudrocks, as seen here on Farm Brits Eigendom No 374/25.

Figure 19: Weathered grey-green and purple-brown overbank mudrocks of the Abrahamskraal Formation exposed near the Amosrivier on Farm Brits Eigendom No 374/10.

Figure 20: Excellent exposures of Abrahamskraal Formation mudrock and sandstone facies along the course of the Amosrivier on Farm Brits Eigendom No 374/10 (hammer = 30 cm).

Figure 21: Possible upward-coarsening packages within the upper Abrahamskraal Formation or lower Poortjie Member exposed on the banks of the Amosrivier, Farm Brits Eigendom No 374/25, with weathering-out ferruginous carbonate concretions on the skyline.

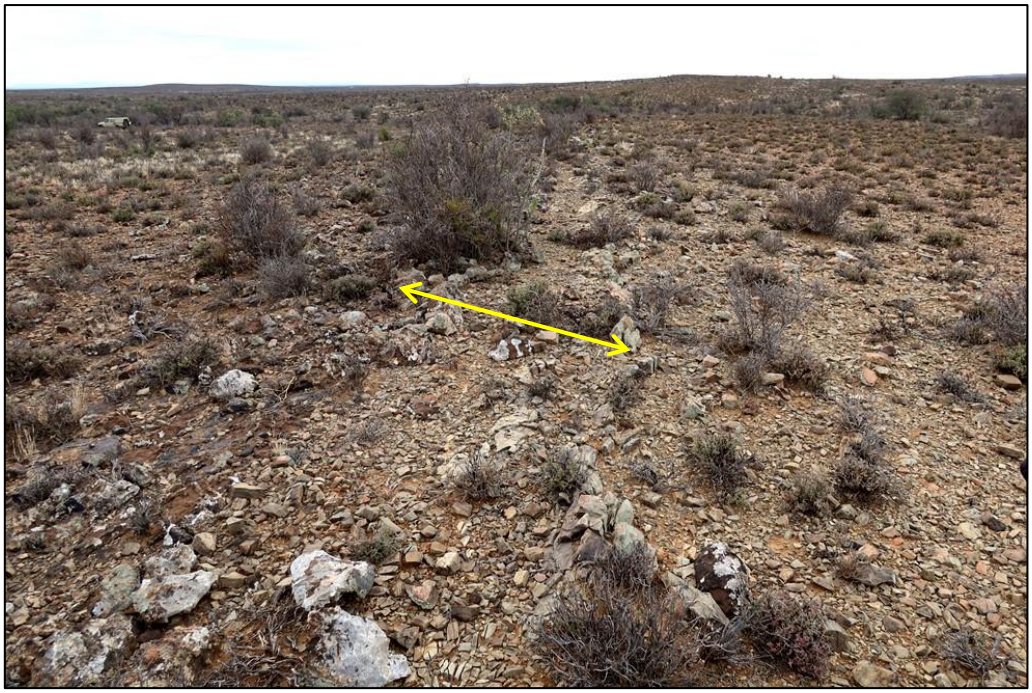

Figure 22: Laterally persistent, gently-dipping horizon of prominent-weathering, pale greyish-green tuffite (admixture of volcanic ash and fine-grained terrigenous sediment) within the upper Abrahamskraal Formation in the south-eastern sector of Farm Brits Eigendom No 374/25 (arrowed). This rock type can be accurately dated by radiometric means and is also an important raw material for stone artefacts locally.

Figure 23: Low, highly-jointed exposure of pale greenish-grey tuffite with blanket of eluvial tuffite gravels exposed within the Abrahamskraal Formation just to the east of Dankbar homestead on Farm Brits Eigendom No 374/10 (hammer = 30 cm).

Figure 24: Excellent vertical sections through interbedded sandstone and mudrock facies of the upper Abrahamskraal Formation (or perhaps lowermost Poortjie Member) on the steep banks of the Amosrivier on the western edge of Farm Brits Eigendom No 374/25.

Figure 25: Thick package of grey-green mudrocks with a pedogenic calcrete horizon within the lower part of the Poortjie Member (or uppermost Abrahamskraal Formation), Farm Brits Eigendom No 374/10. This exposure has yielded small dicynodont skulls.

Figure 26: Tabular-bedded channel sandstone body of the Poortjie Member with a sharp, somewhat erosive base forming a low kranz on the banks of the Amosrivier, Farm Brits Eigendom No 374/25.

Figure 27: Typical tabular-bedded, "golden brown", friable, medium-grained channel sandstones of the Poortjie Member, seen here in the central portion of Farm Brits Eigendom No 374/25.

Figure 28: Golden-brown Poortjie Member sandstone units with an intervening package of grey-green overbank mudrocks, south-western margin of Farm Brits Eigendom No 374/10, just west of the Amosrivier.

Figure 29: Interbedded medium-bedded sandstone beds and purple-brown or grey-green mudrocks within gullied exposures of the Poortjie Member, Stofkraal se Koppe, Farm Brits Eigendom No 374/10.

Figure 30: Relict pinnacle koppie of Poortjie Member mudrocks on the north-eastern margins of the Farm Brits Eigendom No 374/10.

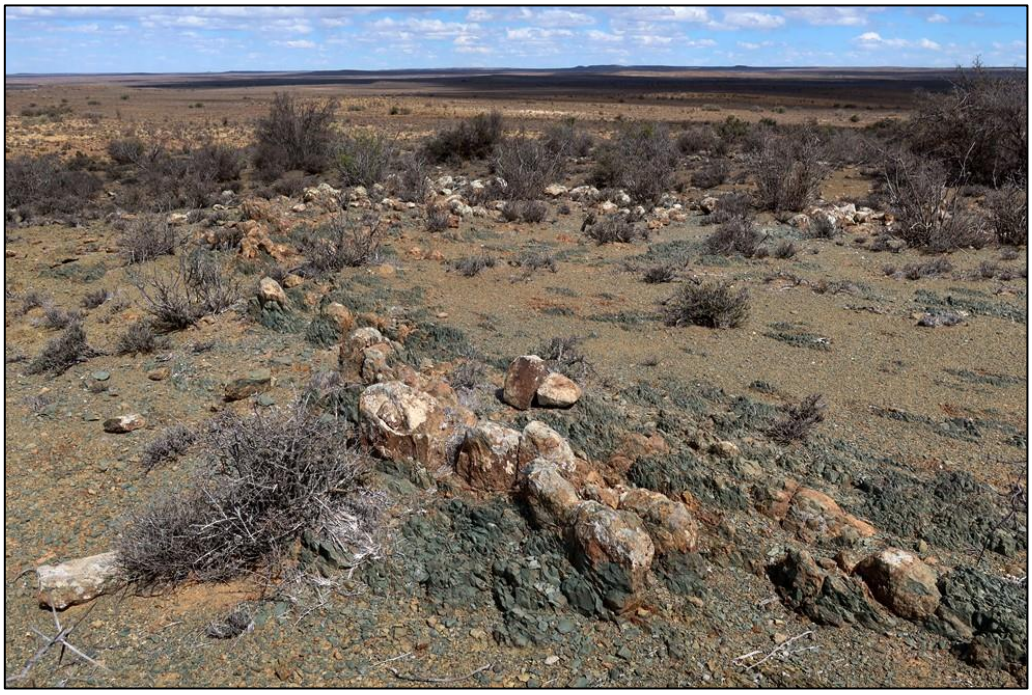

Figure 31: Horizon of prominent-weathering ferruginous carbonate concretions within mudrocks of the Poortjie Member on Stofkraal se Koppe, Farm Brits Eigendom No 374/10.

Figure 32: Dense clusters of sphaeroidal gypsum rose pseudomorphs within grey-green mudrocks of the Poortjie Member – probably of lacustrine origin (scale in cm and mm), southern portion of Farm Brits Eigendom No 374/25.

Figure 33: Formation of subrounded sandstone corestones by weathering of well-jointed channel sandstone bodies of the Abrahamskraal Formation or lower Poortjie Member, Farm Brits Eigendom No 374/10, west of the N12.

Figure 34: Unconsolidated sandy and gravelly alluvial deposits along the banks of the Amosrivier, Farm Brits Eigendom No 374/25 (hammer = 30 cm).

Figure 35: Subcircular lens of thickened, partially calcretised sandy to gravelly deposits, intensely burrowed by small mammals. Such heuweltjies are often associated with tall shrubby vegetation and appear as dispersed pale spots on satellite images.

Figure 36: Thick local development of pale creamy calcrete (pedogenic limestone) within alluvial sands and gravels as well as veining the underlying bedrocks, south-western margins of Farm Brits Eigendom No 374/10 just east of the N12 (hammer = 30 cm). The calcrete is related to a spring along the Amosrivier and is associated with rich Middle Stone Age artefact assemblages.

Figure 37: Intensely orange-patinated eluvial gravels of tuffite dominate surface gravels locally, as here in the south-eastern corner of Farm Brits Eigendom No 374/25. They appear as orange patches on satellite images.

Figure 38: Surface gravels dominated by eluvial ferruginous carbonate concretionary material, southern margins of Farm Brits Eigendom No 374/25. Such areas are a focus for recording fossil vertebrates.

Figure 39: Thrust plane marked by well-developed quartz veining with mineral lineation and mylonites (crush breccias), south-western sector of Farm Brits Eigendom No 374/25 (hammer = 30 cm).

Figure 40: Block (c. 12 cm long) of quartzose mylonitic crush breccia associated with low angle thrust faults such as that illustrated above.

Figure 41: South-dipping thrust plane between a competent channel sandstone package and less resistant, dark mudrocks of the Poortjie Member, N12 road cutting near Amospoortjie homestead.

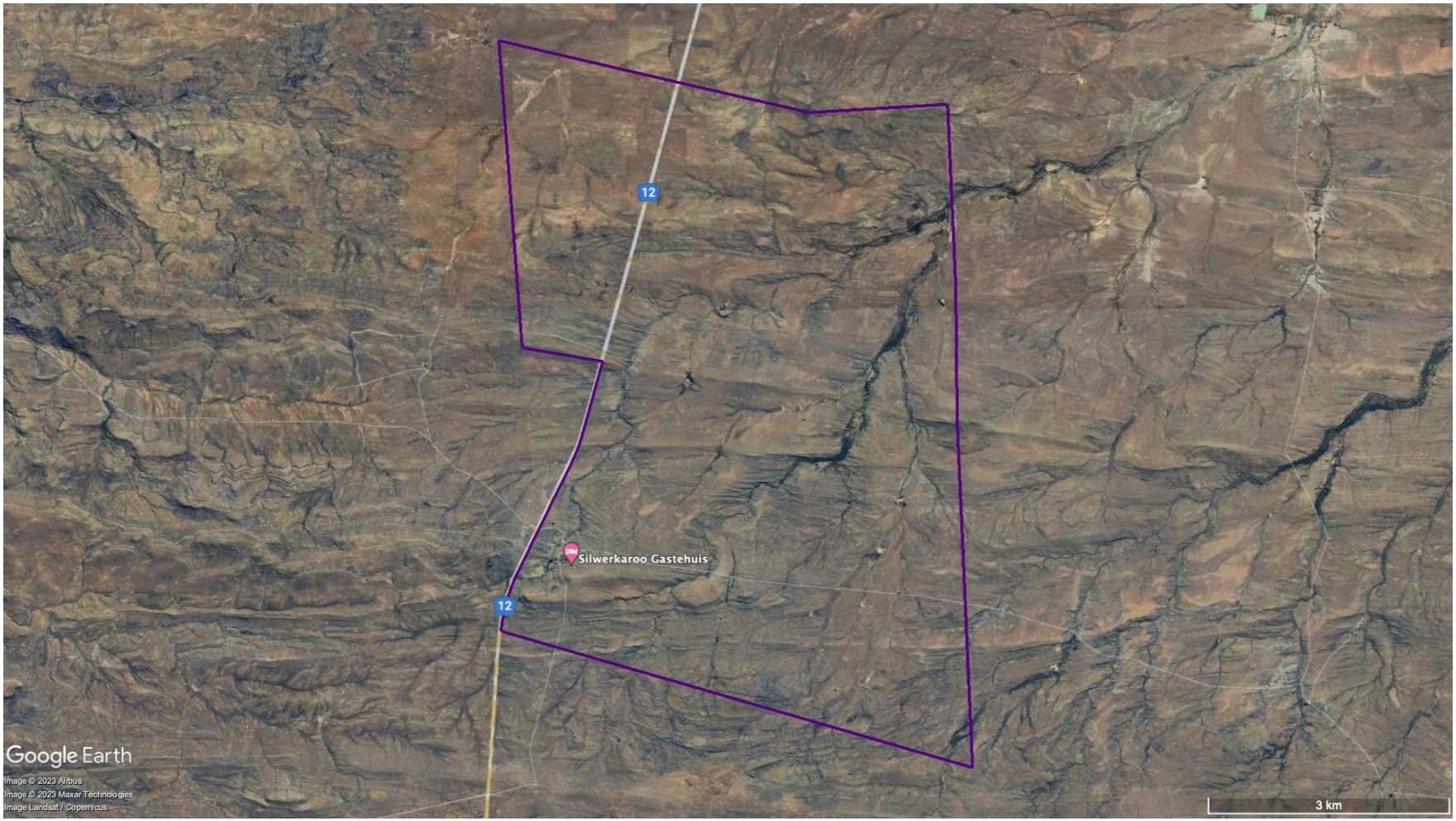

Figure 42: Google Earth© satellite image showing the Kraaltjies WEF project area on Farm Brits Eigendom No 374 Portions 10 and 25 (purple polygon).The pronounced east-west grain of the Palaeozoic bedrocks, a consequence of pronounced Permo-Triassic folding and faulting during the Cape Orogeny, is clearly seen here. Paler areas reflect (1) cover by surface gravels such as vein quartz and tuffite or (2) Late Caenozoic alluvium along major drainage lines. *N.B*. North is towards the LHS of the image.

5.2. Palaeontological heritage

In this section of the PIA report fossil assemblages that are already known from the main sedimentary rock units represented within the WEF project area are outlined, while the limited corpus of new fossil material recorded during the present field assessment is listed and illustrated. GPS locality details and brief descriptions of fossil material for numbered palaeontological sites are provided in Appendix 1 and key sites are mapped therein on the satellite image in Figures A1.1 to A1.3. Please note that these fossil sites are usually only *representative* of the relevant rock units as a whole; it is very likely that comparable but unrecorded fossil occurrences occur elsewhere within the outcrop area of these units. The fossil sites listed in Appendix 1 do *not* therefore represent a comprehensive record of all fossil sites within the study area. Please also note that fossil locality data provided in this report is *not* for general publication for heritage conservation reasons.

5.1.1 Tapinocephalus *Assemblage Zone palaeontology*

Continental (terrestrial / fluvial /lacustrine) fossil biotas within the upper Abrahamskraal Formation and the lower part of the Poortjie Member (Teekloof Formation) that crop out within the WEF and associated Infrastructure project area are assigned to the ***Tapinocephalus* Assemblage Zone** of late Middle Permian (Capitanian) age (*c*. 265 – 260 Ma) according to the latest biozonation map of Day and Rubidge (2020) (**Figure 43**). The *Tapinocephalus* Assemblage Zone has recently been revised by Day and Rubidge (2020) and subdivided into two subzones (**Figure 11**). The younger and more fossil-rich of these, the ***Diictodon – Styracocephalus* Subzone** that is of latest Middle Permian / Late Capitanian age (*c*. 262-260 Ma), is mapped within the present WEF project area. This situation may change, however, as new fossil material is recorded and analysed in this comparatively understudied sector of the Main Karoo Basin.

The fossil biota of the the *Tapinocephalus* Assemblage Zone is characterised by a range of vertebrate fossil groups, notably large dinocephalian therapsids, primitive pareiasaur reptiles and small-bodied dicynodonts *plus* a variety of carnivorous therocephalians (**Figure 44** to **Figure 46**). The main categories of fossils expected within the *Tapinocephalus* fossil biozone (Keyser & Smith 1977-78, Anderson & Anderson 1985, Smith & Keyser 1995a, MacRae 1999, Rubidge 2005, Smith *et al.* 2012, Cole *et al.* 2016, Day & Rubidge 2020) include:

- isolated petrified bones as well as rare articulated skeletons of tetrapods (*i.e.,* air-breathing terrestrial vertebrates) such as true **reptiles** (notably large herbivorous pareiasaurs like *Bradysaurus*, small insectivorous millerettids, the small, turtle-like *Eunotosaurus*), rare pelycosaurs, and diverse **therapsids** or “mammal-like reptiles”. This last group includes numerous genera of large-bodied, herbivorous and carnivorous dinocephalians, herbivorous dicynodonts (with several new genera recently described), flesh-eating biarmosuchians, rare, generally small-bodied gorgonopsians and a variety of therocephalians, including some sizeable apex predators.

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*, often represented by scattered scales rather than intact fish).
- freshwater **bivalves** (*Palaeomutela*), **insects.**
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, lungfish burrows, fish swimming trails, arthropod tracks, coprolites (fossil droppings) and plant root or stem casts (*e.g.,* reedy sphenophytes).
- **vascular plant remains** (usually sparse and fragmentary), including leaves, twigs, roots and petrified woods ("*Dadoxylon*") of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetails) as well as rare lycophytes (club mosses).

In general, tetrapod fossil assemblages in this zone are dominated by a wide range of dinocephalian genera and small therocephalians *plus* pareiasaur parareptiles while the dicynodonts and rare gorgonopsian predators are mostly small-bodied forms. Vertebrate fossils in this zone are, on the whole, much rarer than seen in younger assemblage zones of the Lower Beaufort Group, with almost no fossils to be found in the lowermost beds. Jirah & Rubidge (2014, their Figure 5) record a higher density of vertebrate fossils within the sandstone-rich uppermost Abrahamskraal Formation succession below the Poortjie Member in the Merweville – Prince Albert Road sector of the southern Karoo (*cf* Loock *et al.* 1994 who do not record fossils in this uppermost part of their Abrahamskraal Formation section near Laingsburg, their Figure 3).

Vertebrate fossils in the *Tapinocephalus* Assemblage Zone occur in association with *both* mudrocks and channel sandstones, including reworked "rolled" bones and teeth within thin intraformational conglomerates (*beenbreksie*) at the base of channel sandstones (Rossouw & De Villiers 1952, Turner 1981, Smith & Keyser 1995a, Day & Rubidge 2020). Many of the vertebrate remains are associated with calcretised palaeosol (ancient soil) horizons, including postcranial bones and intact skulls that are largely or entirely enclosed within hard pedocrete nodules. Skeletal remains eroding out of mudrocks are often scattered and highly weathered; they may also show evidence of pre-burial suncracking as a result of protracted exposure on the ancient Karoo floodplain.

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

Fossil locality distribution maps for the Lower Beaufort Group in the southern sector of the Main Karoo Basin in the region to the south of Beaufort West show very few records of vertebrate fossils in this area (**Figure 39**). This is apparent on early palaeontological maps of Kitching (1977) and Keyser & Smith (1977-1978) as

well as from the published 1: 250 000 geological sheet 3222 Beaufort West (Johnson & Keyser 1979, Toerien 1979). The Beaufort West geological sheet shows just a few fossil sites of the *Tapinocephalus* and *Pristerognathus* Assemblage Zones, as previously defined, from better exposed terrain to the west of the N12, *outside* and southwest of the present WEF project area. The more recent fossil site map of Nicolas (2007) (**Figure 47**) features a few sites just to the west of the N12 and one site further east (*possibly* located within or close to the Kwagga 3 WEF project area).

Several additional vertebrate fossil sites – mostly small-bodied dicynodonts *plus* poorly-cranial and postcranial remains of large herbivorous tetrapods (pareiasaurs and dinocephalians) with much rarer carnivorous therapsids as well as occasional tetrapod and lungfish burrow casts– have been recorded recently recorded within the adjoining project areas for the Trakas, Beaufort West, Heuweltjies and Kwagga 1-3 WEFs in the vicinity of the present WEF project area as well as for the Koup 1 and Koup 2 WEF project areas further to the west (See references under Almond). The fossil sites recorded within the northern sector of the adjoining Trakas and Beaufort West WEF project areas, to the south of the Kraaltjies WEF project area, are mapped in Appendix 1, Figures A1.1 to A1.3. GPS data and brief descriptions for these sites are provided by Almond (2018, 2022d). This new fossil material may ultimately assist with the detailed fossil biozonation of the tectonically complex southern Karoo margins.

Fossil finds of any sort are very sparse occurrence within the Abrahamskraal Formation bedrocks within the Kraaltjies WEF project area, with only ~30 recorded fossil sites from *c*. 80 exposures examined (See tabulated fossil data and satellite site map in Appendix 1). In part, this is due to (1) the low levels of bedrock exposure in the region as well as, perhaps, (2) the moderately high levels of tectonic deformation locally and (3) weathering of bedrocks related to the ancient African palaeosurface. Due to the high levels of deformation (folding, faulting), the precise stratigraphic position (to member level) of new fossil finds is hard to determine while vertebrate fossils (*e.g.,* many skulls within nodules) often cannot be identified until they are prepared in the lab. For this reason, it is not feasible at present to assign the fossil material to specific stratigraphic members within the Abrahamskraal Formation.

Selected examples of new fossils recorded within the Kraaltjies WEF project area are illustrated in **Figure 48** to **Figure 73** below (See Appendix 1 for tabulation and satellite mapping of all new sites).

Most of the vertebrate fossils recorded from the upper Abrahamskraal Formation within the Kraaltjies WEF project area comprise unidentifiable, *ex situ* postcranial chunks of large animals (pareiasaurs or dinocephalians) within surface float as well as a number of small dicynodont skulls, generally preserved within pedocrete horizons. The most prolific fossil site is located along the crest of a low mudrock *koppie* towards the southern edge of Farm Brits Eigendom No 374/25 and *c*. 3 km southeast of Amosportjie homestead. This site has yielded partial cranial and postcranial remains of more than one medium to large (dog- to wolf-sized) therocephalian predator, one with a well-preserved set of savage teeth (probable a lycosuchid, **Figure 48** to **Figure 50** and **Figure 45**; *cf* Pusch *et al.* 2020, Van den Heever 1980, 1987, 1994), abundant disarticulated scales and other skeletal remains of palaeoniscoids (primitive bony fish) within a thin calcareous sandstone

concretionary bed, a small dicynodont skull, a cluster of phosphatized coprolites (fossil droppings, *cf* Smith & Botha-Brink 2011), a few isolated dinocephalian teeth, some equivocal sandstone casts of tetrapod and lungfish burrows as well as clusters and scatters of fragmentary bones of probable dinocephalian affinity. This biota was probably associated with a lake or pond setting on the Middle Permian floodplain, as also suggested by the local occurrence of gypsum roses and horizons of loaded sandstones (**Figure 17**, **Figure 18** and **Figure 32**). The fish scale morphology suggests the common, long-ranging ancient Karoo palaeoniscoid *Namaichthys digitata* (*cf* Bender *et al.* 1991, Bender 2000). This fossil-rich area on Farm Brits Eigendom No 374/25 has been designated a High Palaeosensitivity area (see red polygon which includes a buffer zone in satellite map Appendix 1, Figure A1.2).

Vertebrate fossils are – as expected – far less common within the Poortjie Member exposure areas, mainly consisting of several well-preserved skulls with articulated lower jaws of small dicynodonts. These include both *Diictodon* as well as one or more other genera with a broad intertemporal zone. No fossil plant material (including petrified wood) was recorded within the Lower Beaufort Group during this study.

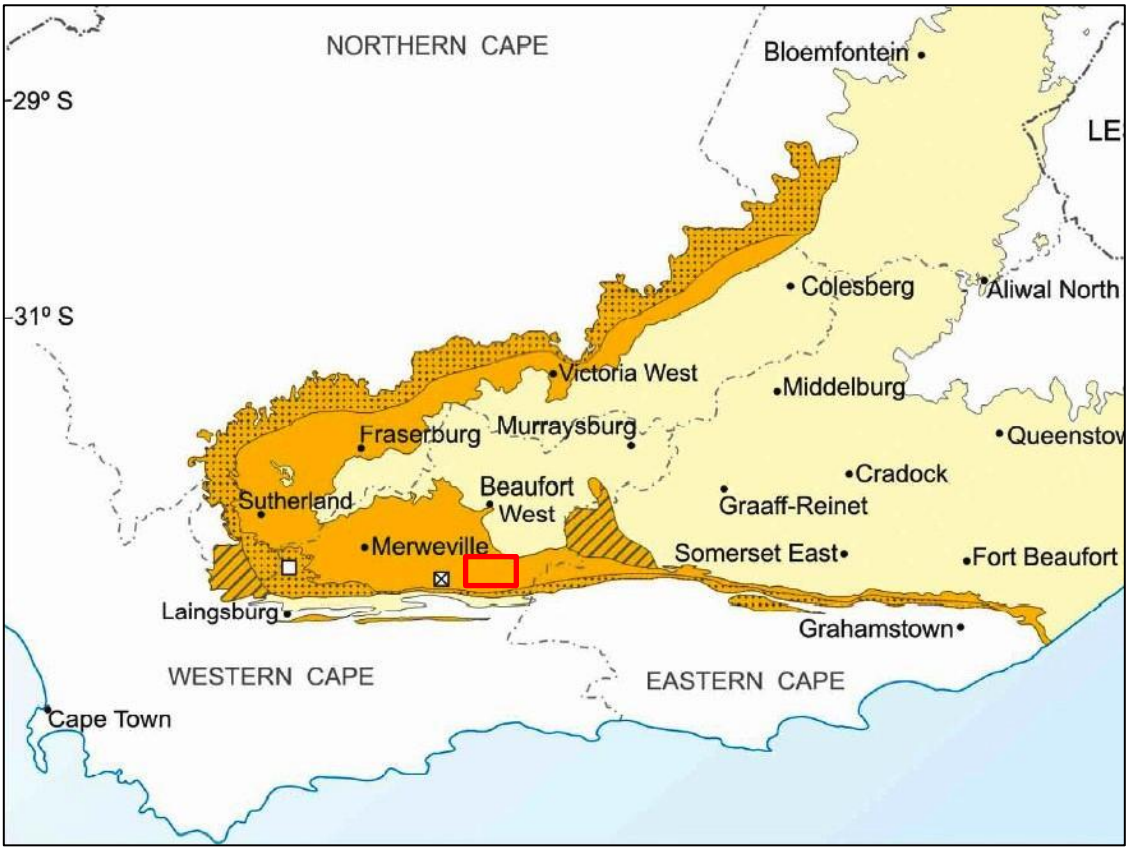

Figure 43: Map showing the known or inferred distribution of late Middle Permian (Capitanian) continental fossil assemblages of the revised *Tapinocephalus* Assemblage Zone around the margins of Main Karoo Basin (From Day & Rubidge 2020). The present combined Kraaltjies WEF and associated Infrastructure project area along the southern Karoo margins to the south of Beaufort West lie within the outcrop area of the recently recognised *Diictodon – Styracocephalus* Subzone (plain orange area on map) but this is currently supported by very limited palaeontological data in this historically under-recorded sector of the Karoo. New, potentially identifiable fossil vertebrate material from the WEF project area is therefore of considerable biostratigraphic interest.

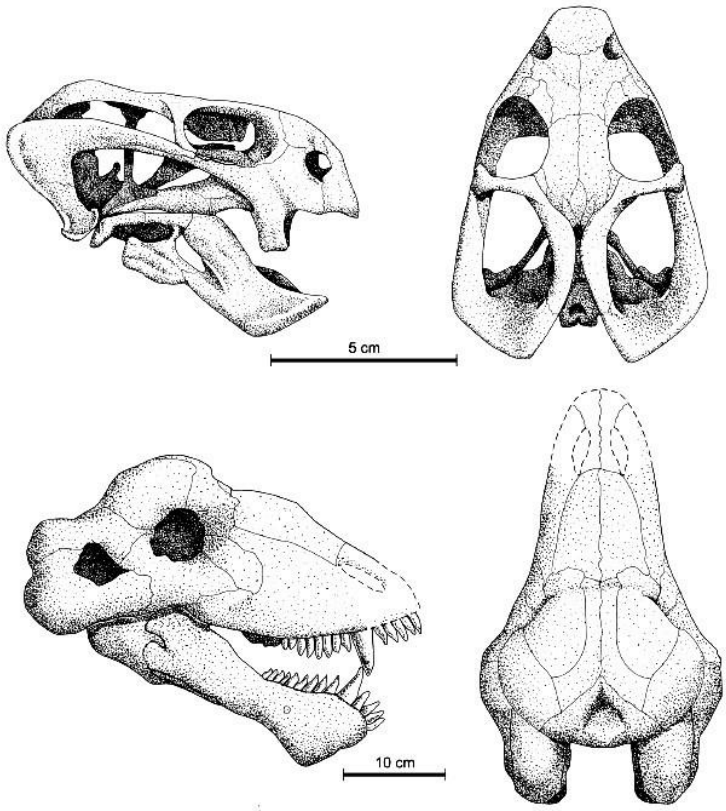

Figure 44: Skulls of two key vertebrate herbivores of the recently defined *Diictodon* – *Styracocephalus* Subzone (upper portion of the *Tapinocephalus* Assemblage Zone) which extends across the end – Middle Permian (Capitanian) Extinction Event of 260 Ma (million years ago). *Diictodon* (above) was a small-bodied, burrowing dicynodont therapsid ("mammal-like reptile") while *Styracocephalus* (below) was one of the longest-surviving members of the dinocephalians, a major group of large-bodied herbivorous therapsids (From Day & Rubidge 2020).

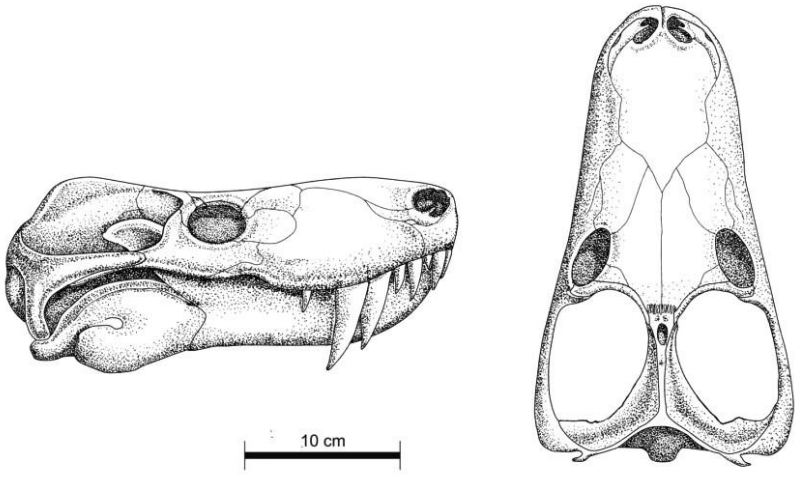

Figure 45: Skull of the primitive, wolf-sized therocephalian predator *Lycosuchus*, one of the few survivors of the late Middle Permian extinction event which is recorded from the upper *Tapinocephalus* and lower *Endothiodon* Assemblage Zones in the Main Karoo Basin (image from Day & Smith 2020).

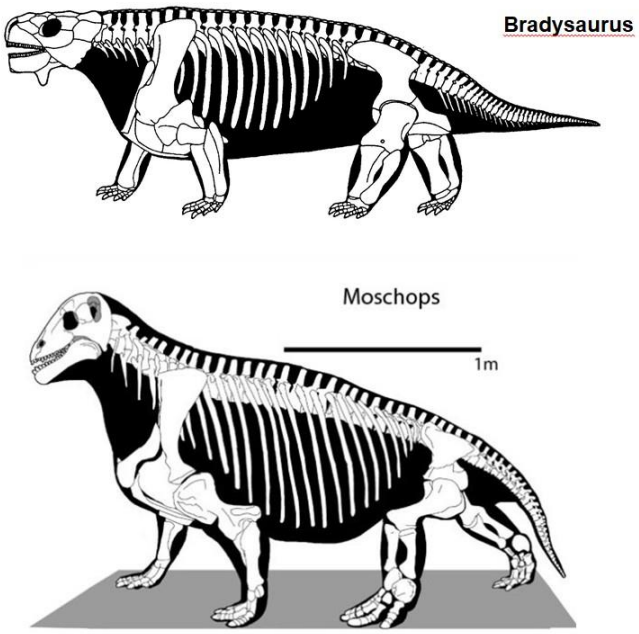

Figure 46: Two unrelated subgroups of rhino-sized, herbivorous tetrapods that are represented within the Middle Permian *Tapinocephalus* Assemblage Zone: bradysaurine pareiasaur reptiles (above) and dinocephalian therapsids (below). Fossil remains of both subgroups have been recorded from within or close to the project area south of Beaufort West. Fragmentary postcranial remains of these large-bodied tetrapods are often difficult to assign to one or other subgroup, especially when weathered.

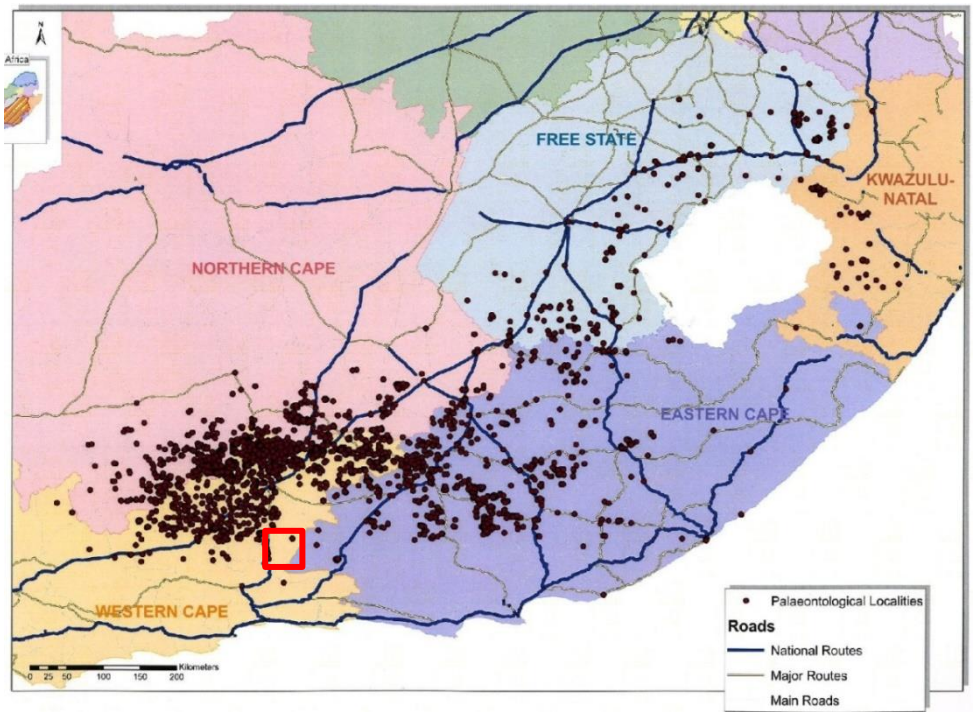

Figure 47: Distribution of recorded vertebrate fossil sites within the within the Lower Beaufort Group of the Main Karoo Basin (modified from Nicolas 2007). The WEF project area to the south of Beaufort West is located within the small red square. The very low density of recorded fossil sites here, to the east of the N12 and on the SW periphery of the Aberdeen *vlaktes*, is notable.

5.1.2 Late Caenozoic superficial deposits palaeontology

The diverse Late Caenozoic superficial deposits within the South African interior have been comparatively neglected in palaeontological terms. However, sediments associated with ancient drainage systems, springs and pans in particular may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals as well as remains of reptiles like tortoises (*e.g.* Skead 1980, Klein 1984b, Brink, J.S. 1987, Bousman *et al.* 1988, Bender & Brink 1992, Brink *et al*. 1995, MacRae 1999, Meadows & Watkeys 1999, Churchill *et al*. 2000, Partridge & Scott 2000, Brink & Rossouw 2000, Rossouw 2006, De Ruiter *et al.* 2010, Backwell *et al.* 2017). Other late Caenozoic fossil biotas that may occur within these superficial deposits include non-marine molluscs (bivalves, gastropods), ostrich egg shells, trace fossils (*e.g.,* calcretised termitaria, coprolites, invertebrate burrows, rhizocretions), and plant material such as peats or palynomorphs (pollens) in organic-rich alluvial horizons (Scott 2000) and diatoms in pan sediments. In Quaternary deposits, fossil remains may be associated with human artefacts such as stone tools and are also of archaeological interest (*e.g.,* Smith 1999 and refs. therein). Ancient solution hollows within extensive calcrete hardpans may have acted as animal traps in the past. As with coastal and interior limestones, they might occasionally contain mammalian bones and teeth (perhaps associated with hyaena dens) or invertebrate remains such as snail shells.

Apart from occasional “rolled” fragments of fossil bone reworked from the Lower Beaufort Group bedrocks, which are usually unidentifiable, no fossil remains were recorded within the Late Caenozoic superficial deposits within the Kraaltjies WEF project area.

Approximately 80 bedrock exposures were examined during the course of the 3.5-day site visit by three experienced heritage professionals, with fossils recorded at only 30 sites. It is concluded that, although scientifically important fossil material is present within the Palaeozoic bedrocks within the Kraaltjies WEF project area, they are sparsely distributed and largely unpredictable here. Apart from these fossil sites (most of which remain unrecorded), the palaeosensitivity of the Kraaltjies WEF project area is LOW overall.

Figure 48: Skull and incomplete, semi-articulated postcrania (limb bones, pelvis etc) of large dog-sized, predatory therocephalian (probably a lycosuchid) *in situ*, enclosed in brownish concretionary pedogenic calcrete within mudrocks of the upper Abrahamskraal Formation, Portion 25 of the Farm Brits Eigendom No 374 (Loc. 067). Scale = 15 cm.

Figure 49: Detail of the skull of the therocephalian specimen illustrated above in dorsal view showing large, dorsally-facing temporal openings typical of this group of theriodont therapsids – the apex predators of the late Middle Permian Period.

Figure 50: Snout of the therocephalian illustrated above showing the enlarged canine fang and savage incisor teeth (See also reconstruction of lycosuchid skull shown in Figure 47). Block is c. 11.5 cm across as seen here.

Figure 51: Partial snout of therocephalian therapsid with tusks and other teeth, preserved in float, upper Abrahamskraal Formation, Portion 25 of the Farm Brits Eigendom No 374 (Loc. 065). Block as seen here is 7 cm across.

Figure 52: Part of scatter of disarticulated postcranial remains of a medium-sized tetrapod (perhaps a therocephalian), including limb bones, vertebrae, ribs, possible girdles *etc*., preserved in part in situ within calcareous siltstone with abundant fish scales, upper Abrahamskraal Formation, Portion 25 of the Farm Brits Eigendom No 374 (Loc. 066). Bone exposed here is 12 cm long.

Figure 53: Float blocks of calcareous concretionary siltstone in float containing additional postcranial remains of a medium-sized tetrapod, upper Abrahamskraal Formation, Portion 25 of the Farm Brits Eigendom No 374 (Loc. 066). Scale in cm.

Figure 54: Blocks of concretionary carbonate-cemented lacustrine mudrock containing abundant dark phosphatic fossil remains, including shiny, phosphatic, highly ornamented disarticulated scales of palaeoniscoid bony fish (*cf. Namaichthys*). Portion 25 of the Farm Brits Eigendom No 374 (Loc. 066). Scale in cm. Scale in cm and half cm.

Figure 55: Float block from the same locality as above showing basal lag horizon or reworked layer of small fish scales and other fossil fragments. Block is 12 cm long.

Figure 56: Concentration of small (2-3 cm long), ellipsoidal, dark, shiny-grey coprolites or phosphatic concretions within green-grey mudrocks. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 156). Scale in cm and mm.

Figure 57: Two robust teeth (*c*. 2.5 cm long) of a dinocephalian therapsid found in float, associated with a scatter of bone blocks (see below). Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 159). Scale in cm and mm.

Figure 58: Scatter of small to medium-sized, fragmentary bone chunks of a large-bodied tetrapod - probably a dinocephalian based on the isolated teeth from the same site illustrated above. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 159). Scale in cm and mm.

Figure 59: Two fragmentary, highly weathered bone chunks of a sizeable tetrapod (pareiasaur or dinocephalian) in surface float. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 138). Scale in cm and half cm.

Figure 60: Ferruginous carbonate concretion containing numerous fragments (or perhaps small articulated elements) of spongy bone – possibly the weathered / sun-cracked postcranial remains of large tetrapod. Upper Abrahamskraal Formation or lower Poortjie Member, Portion 10 of the Farm Brits Eigendom No 374. Kaatjie se Kop (Loc. 101). Block is 8.5 cm across.

Figure 61: Postcranial fragments (limb bones/girdle) and vertebral centrum of a large-bodied tetrapod preserved in float. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 070). Scale = 15 cm.

Figure 62: Unidentified postcranial or cranial bone of a large-bodied tetrapod preserved within a pedogenic concretion in float. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 090). Scale in cm and mm.

Figure 63: Small dicynodont skull exposed in oblique dorso-lateral view, embedded in grey-green overbank siltstones. Poortjie Member siltstone package on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 112). Skull is *c*. 7 cm long.

Figure 64: Short, globular skull with articulated lower jaw of small-bodied dicynodont, lying right side-up, enclosed within calcrete concretion within grey-green overbank mudrocks exposed in a river bed. Uppermost Abrahamskraal Fm or lower Poortjie Member on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 111). Scale in cm.

Figure 65: Small dicynodont skull with broad intertemporal region embedded within a calcrete concretion in overbank mudrocks. Uppermost Abrahamskraal Fm or lower Poortjie Member on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 104). Skull is *c*. 12 cm long.

Figure 66: Small tetrapod skull (probably dicynodont) preserved within palaeocalcrete concretion in hackly-weathering mudrocks. Upper Abrahamskraal Formation on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 096). Block as seen here is *c*. 13 cm long.

Figure 67: Small dicynodont skull (facing to left) with articulated lower jaw and broad intertemporal region preserved within pedogenic calcrete concretion. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 089). Scale in cm and mm.

Figure 68: Small dicynodont skull with articulated lower jaw embedded in calcrete concretion recorded within surface float. Probably uppermost Abrahamskraal Fm. Portion 10 of the Farm Brits Eigendom No 374 (Loc. 117). Skull is *c*. 9 cm long.

Figure 69: Poorly-preserved tetrapod skull enclosed within pedogenic carbonate nodule in float. Poortjie Member on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 083). Concretion is *c*. 13 cm long.

Figure 70: Two fragmentary, indeterminate bones enclosed within palaeocalcrete concretions among surface float. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 064). Larger block is c. 12.5 cm long.

Figure 71: Possible but equivocal sandstone cast of an inclined tetrapod burrow embedded within crumbly, dark grey overbank mudrocks. Upper Abrahamskraal Formation on Portion 25 of the Farm Brits Eigendom No 374 (Loc. 162). Scale = 15 cm.

Figure 72: Possible sandstone lungfish burrow cast with an elliptical cross-section excavated in upper Abrahamskraal Formation mudrocks on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 116). Scale in cm.

Figure 73: Strap-shaped fossil structure (*c*. 3 cm wide) – possibly an invertebrate burrow – within grey-green overbank mudrocks, locally showing a dark, pearly phosphatic sheen. Probable upper Abrahamskraal Formation on Portion 10 of the Farm Brits Eigendom No 374 (Loc. 115).

6. IDENTIFICATION AND ASSESSMENT OF IMPACTS

The potential impact of the proposed Kraaltjies WEF development and the associated Infrastructure on scientifically important, legally-protected local fossil heritage resources is evaluated in this section of the report and summarized in **Table 2** to **Table** below. This assessment applies only to the *construction phase* of the developments since further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facility are not anticipated. The first assessment **Table 2**) applies to all the key infrastructure described in Section 3 that will be situated within the main WEF project area (*i.e.* wind turbine foundations, access roads, on-site substation, pylons, underground cables, as well as the construction laydown areas and operational and maintenance buildings, guard house, BESS *etc*).

6.1 Palaeontological sensitivity of the project area

The proposed Kraaltjies WEF and associated infrastructure project area is located in a region of the Great Karoo that is underlain by potentially fossiliferous sedimentary rocks of Late Palaeozoic and younger, Late Tertiary or Quaternary, age. In particular, these include (1) Middle Permian continental sediments of the Abrahamskraal and Teekloof Formations (Lower Beaufort Group, Karoo Supergroup) which contain scientifically important fossils of vertebrates, trace fossils and terrestrial plants, as well as (2) Late Caenozoic alluvium that may contain important mammalian remains such as teeth and bones (These rock units and their fossils are described in more detail in Section 5 of this report).

The generally high palaeontological heritage sensitivity of the Lower Beaufort Group bedrocks in the Great Karoo is emphasized on the SAHRIS palaeosensitivity map maintained by SAHRA as well as the DFFE Screening Tool (**Figure 74**). The palaeontological heritage Site Sensitivity Map prepared for the Kraaltjies WEF and associated infrastructure project area using the DFFE Screening Tool identifies areas underlain by the Lower Beaufort Group as being of a Very High Sensitivity. Small, elongate to irregularly shaped areas of Medium Palaeosensitivity mapped on the margins of but *outside* the present study area refer to thick Late Caenozoic alluvial deposits of the Aberdeen *Vlaktes*. However, both desktop and field studies within this and neighbouring WEF project areas (*e.g.* Trakas, Beaufort West, Heuweltjies, Kraaltjies, Kwaggas 1-3 WEFs) demonstrate that, while a significant number of scientifically valuable, well-preserved fossils do indeed occur in the region, sometimes in high concentrations, in practice they are usually scarce here and their distribution is to a large extent unpredictable. As concluded in Section 5 of this report (see also Almond 2021f, 2022d), well-preserved fossils of scientific and conservation significance are very sparse within the Kraaltjies WEF and associated Infrastructure project area. This is in part due to low levels of bedrock exposure related to a regional relict land surface as well as (2) high levels of tectonic deformation (folding, faulting, cleavage *etc*). (*N.B.* Additional fossils are preserved in the subsurface and may be impacted by excavations during the construction phase).

It is concluded that, in practice, the Kraaltjies WEF and associated infrastructure project area has an overall LOW Palaeosensitivity as far as palaeontological heritage is concerned. The potential for rare, and largely unpredictable, unrecorded fossil sites preserved within bedrocks and consolidated older alluvial sediments the project areas cannot be entirely discounted, however. The provisional palaeosensitivity mapping shown by the DFFE Screening Tool is accordingly *contested* here.

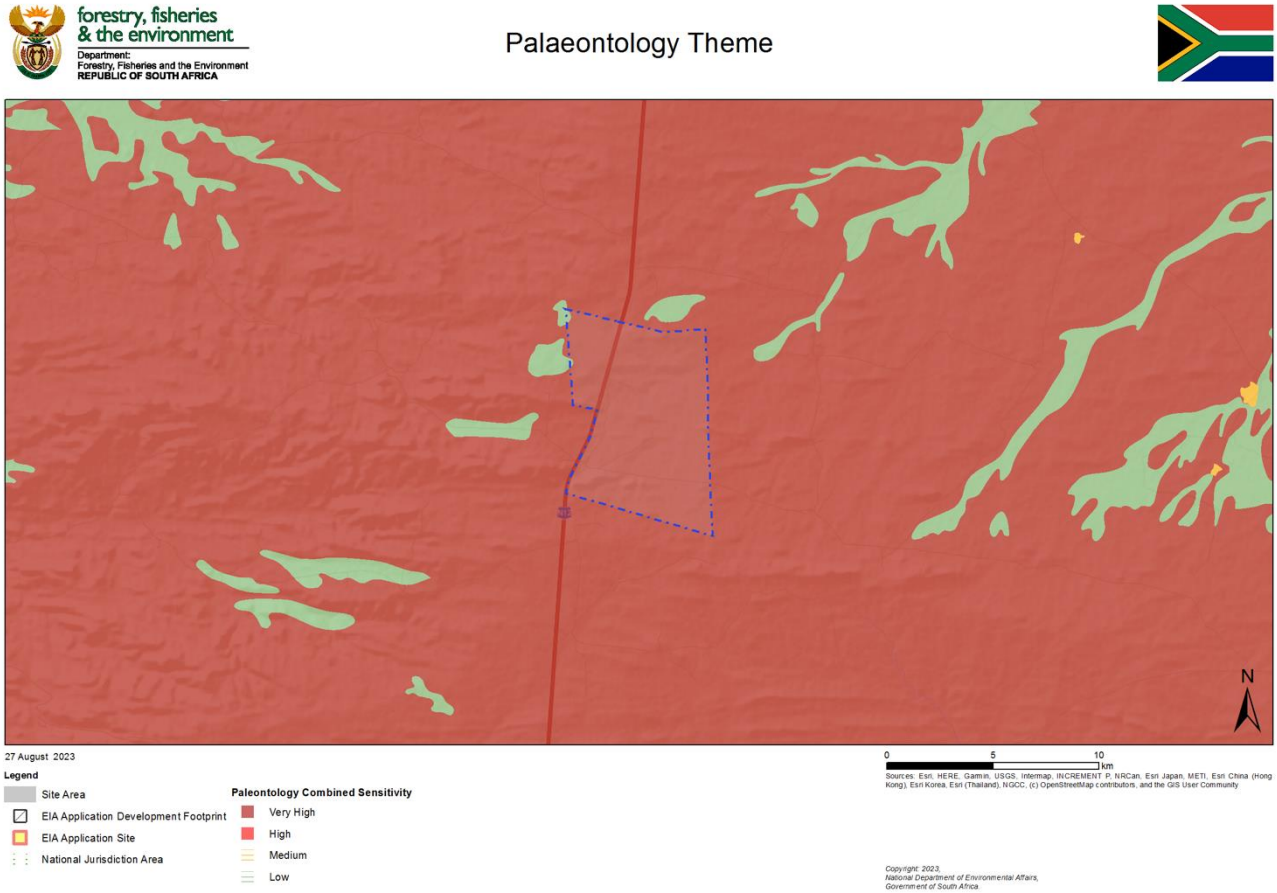

Figure 74: Provisional paleontological sensitivity map for the Kraaltjies WEF and associated Infrastructure project areas based on the DFFE Screening Tool indicating that the entire project areas are of Very High Palaeosensitivity. Due to the scarcity of well-preserved, scientifically important fossils over much of this region, based on desktop studies and fieldwork, it is inferred that most parts of the project areas are in practice of LOW palaeontologically sensitivity. Areas underlain by thick alluvial sediments here are generally of LOW sensitivity, although important concentrations of Caenozoic mammal remains might occur here. The palaeosensitivity mapping shown by the DFFE Screening Tool is contested here.

7. RESULTS OF THE PALAEONTOLOGICAL DESKTOP AND FIELD STUDY

7.1 WEF project area

A combined desktop and field-based review of the palaeontology of the Middle Permian Lower Beaufort Group sediments in the Kraaltjies WEF and associated Infrastructure project area located in the southern Great Karoo region, supplemented by comparable palaeontological heritage impact assessments for a number of other authorized or proposed renewable energy developments in the region, shows that well-preserved fossil remains of scientific and conservation significance are generally scarce in this sector of the Great Karoo. However, a substantial number of scientifically important occurrences of vertebrate fossils have been recorded here during previous PIA studies, and the vertebrate fossils may occur locally in high concentrations along the ridges as well as in low-lying terrain (See References under Almond).

The 3.5-day palaeontological heritage survey of numerous (*c*. 80) exposures of Karoo Supergroup bedrocks as well as Late Caenozoic superficial sediments within the combined Kraaltjies WEF and Associated Infrastructure project area (See fossil locality satellite maps, Appendix 1, Figures A1.1 to A1.3), supplemented by previous field-based studies by Almond (2021f, 2022d), indicates that well-preserved, scientifically valuable fossils are very sparsely distributed in this area. With the possible exception of one partial, *in situ,* articulated therapsid skeleton, most of the very few fossils recorded are only assigned a moderate to low provisional field rating and also lie *outside* (> 20 m) the provisional project footprint. Where possible, scientifically valuable fossil material recorded within the project area has already been professionally collected or sampled for curation in the collections of the Evolutional Study Institute, Wits University, Johannesburg. The occurrence of important fossil remains in the subsurface obviously cannot be excluded and only a small subsample of all surface fossil sites will have been detected by the reconnaissance-level field survey. Broadly comparable palaeontological findings have previously been obtained for the adjoining Trakas WEF, Beaufort West WEF and Kwaggas 1-3 WEF project areas as well as during further WEF PIA work in the region (See references by Almond).

The potentially fossiliferous Permian bedrocks within the WEF project area are mostly mantled with Late Caenozoic colluvial and alluvial deposits as well as surface gravels and gravelly soils, none of which is palaeontologically sensitive in general. None of the recorded fossil sites lies within or very close to (< 20 m) the proposed footprints of the WEF and associated infrastructure and therefore they should not be directly threatened by the proposed development. Several of the recorded fossil sites are associated with areas of good bedrock exposure that tend to occur along major drainage lines (*e.g*. Amosrivier, Dourivier) and that are therefore generally protected by standard environmental buffer zones for water courses. Only one small palaeontological Very High Sensitivity area – located towards the southern edge of Farm Brits Eigendom No 374/25 and characterized by *in situ* therapsid skeletal material and abundant fish remains - has been identified within the project area (see red polygon, including a buffer zone, in satellite image Appendix 1, Figure A1.2). This High Sensitivity area lies outside the WEF and associated infrastructure footprint. If (*and only if*) the WEF receives Environmental Authorization, the approved layout of the WEF and associated Infrastructure must be,

immediately pre-construction, cross-checked by a qualified palaeontological specialist to determine what level of additional palaeontological surveying, monitoring or mitigation is necessary for these projects, if any. Should a palaeontologicalheritage study of selected, potentially sensitive and previously unsurveyed sectors of the authorised footprint be recommended at this stage, this should involve the recording and judicious collection by a professional palaeontologist of valuable fossil material as well as relevant geological data (e.g., on stratigraphic context, preservation style / taphonomy) within or close to (within ~10 m) the project footprint in the Pre-Construction Phase. Since mitigation through professional recording and collection is almost invariably feasible for fossil sites. During the construction phase, the Chance Fossil Finds Protocol summarised in **Appendix 2** should be fully implemented.

The great majority (and probably all) of unrecorded fossil sites within the final project footprint can be effectively mitigated through (1) judicious professional recording and collection complemented by (2) consistent application of a Chance Fossils Finds Procedure during the construction phase itself, as outlined in Section 8 and Appendix 2.

7.2 Identification of Potential Impacts

Existing impacts on local palaeontological heritage resources within the Kraaltjies WEF and associated infrastructure 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.

The construction phase of the proposed WEF and associated infrastructure will entail extensive surface clearance as well as excavations into the superficial sediment cover and underlying bedrocks (*e.g.,* for widened or new access roads, wind turbine foundations, hardstand areas, on-site substation, underground cables, construction laydown area, O&M building and BESS). Construction of the wind energy facility may adversely affect potential fossil heritage within the development footprint by damaging, destroying, disturbing or permanently sealing-in fossils preserved at or beneath the surface of the ground that are then no longer available for scientific research or other public good. The planning, operational and de-commissioning phases of the facility and grid connection are unlikely to involve further adverse impacts on local palaeontological heritage and are therefore not separately assessed in this report. The potential palaeontological heritage resource impacts identified during the PIA assessment can be briefly summarized as follows:

- ***Planning / Pre-construction Phase***

No significant impacts on palaeontological heritage anticipated.

- ***Construction Phase***

Potential Impact 1: Disturbance, damage or destruction of fossil heritage resources preserved at or below the ground due to surface clearance and excavations (especially into sedimentary bedrock).

- ***Operational Phase***

No significant impacts on palaeontological heritage anticipated.

- ***Decommissioning Phase***

No significant impacts on palaeontological heritage anticipated

- ***Cumulative impacts***

Potential loss of a significant fraction of scientifically important fossil heritage – especially fossil vertebrates - preserved within the Abrahamskraal Formation of the southern Great Karoo south of Beaufort West through multiple renewable energy developments in the region.

7.3 Assessment of WEF project impacts

Potential impacts of the construction phase of the proposed Kraaltjies WEF and associated infrastructure on local fossil heritage resources, with and without mitigation, are assessed below in Tables 2 and 3 respectively, according to the Environmental Impact Assessment (EIA) Methodology developed by SiVEST. Further significant impacts on fossil heritage during the planning, operational and decommissioning phases of the facility are not anticipated.

7.3.1 Construction Phase: Disturbance, damage or destruction of fossils

The destruction, damage or disturbance out of context of legally-protected, scientifically-important fossils preserved at the ground surface or below ground that may occur during construction of the WEF entail *direct negative* impacts to palaeontological heritage resources that are confined to the development footprint (*site*). These impacts can often be mitigated but cannot be fully rectified (*i.e.,* they are *irreversible*). All the sedimentary formations represented within the study area contain fossils of *some* sort, and bedrock exposure levels within the development footprint are good, so impacts at some level on conservation-worthy fossil heritage are *probable*. While most (but *not* all) of the fossils concerned are probably of widespread occurrence elsewhere within the outcrop areas of the formations concerned*, some* unique, well-preserved, scientifically-important fossils are known to occur in this region of the Great Karoo. The potential losses of irreplaceable fossil resources without mitigation is therefore conservatively rated as *marginal*. Such impacts are of *permanent* duration. Their intensity / magnitude during the construction phase is rated as *medium* without

mitigation as a precautionary measure since most of the project footprint has not been surveyed on foot. Without mitigation, a NEGATIVE MEDIUM impact significance is accordingly inferred for both the WEF and associated infrastructure project.

Potential negative impacts can be substantially reduced through implementation of the proposed mitigation measures:
If (*and only if*) the WEF receives Environmental Authorization, the approved layout of the WEF and associated Infrastructure must be, immediately pre-construction, cross-checked by a qualified palaeontological specialist to determine what level of additional palaeontological surveying, monitoring or mitigation is necessary for these projects, if any. Should a palaeontologicalheritage study of selected, potentially sensitive and previously unsurveyed sectors of the authorised footprint be recommended at this stage, this should involve the recording and judicious collection by a professional palaeontologist of valuable fossil material as well as relevant geological data (e.g., on stratigraphic context, preservation style / taphonomy) within or close to (within ~10 m) the project footprint in the Pre-Construction Phase. Since mitigation through professional recording and collection is almost invariably feasible for fossil sites. During the construction phase, the Chance Fossil Finds Protocol summarised in **Appendix 2** should be fully implemented.

With mitigation, the impact significance of the proposed WEF project falls to NEGATIVE LOW. Residual negative impacts may be partially offset by improvements to the local palaeontological database as a result of professional mitigation of chance fossil finds. Due to the reconnaissance level of the field survey of the extensive study area, confidence levels for this palaeontological heritage assessment are only moderate (*medium*). These conclusions are supported, however, by several previous palaeontological field assessments undertaken in the broader southern Karoo region by the author (See References under Almond and discussion on cumulative impacts below).

7.3.2 No-Go Option impacts

The No-Go Option, as assessed by the SiVEST system, is rated as NEGATIVE MEDIUM (Table 4) in so far as, even without development, fossils will still be destroyed by natural weathering and erosion (This negative rating is probably exaggerated because of the high values for impact duration and irreversibility, while positive impacts are not taken fully into account). In the case of the No-Go Alternative (*i.e.* no WEF / grid infrastructure development), the possible loss of local heritage resources through construction activities (negative impact) would be avoided while potential improvements in palaeontological understanding through professional mitigation - *i.e.* recording and collection of palaeontological material and data (positive impacts) - would be lost. The slow destruction of fossils exposed at the surface through natural weathering and erosion would continue, but at the same time new fossils are revealed for scientific study. On balance, it is concluded that No-Go alternative would have a *neutral* impact on palaeontological heritage.

7.4 Cumulative impacts

Cumulative impacts addressed here principally concern the *potential* loss of a significant fraction of scientifically valuable and legally-protected fossil heritage preserved within the Abrahamskraal and Teekloof Formations of the southern Karoo margins through multiple alternative energy developments in the region to the south of Beaufort West (**Figure *75*** and Table 1). The cumulative impacts analysis shown in Table 5 is based on the Environmental Impact Assessment (EIA) Methodology developed by SiVEST.

Relevant renewable energy projects within a 35 km radius of the combined Kraaltjies WEF and associated Infrastructure project area are mapped in **Figure *75*** below (No data is available for any other large-scale industrial developments in the region). PIA data for the proposed Leeu Gamka Solar Power Plant is not yet available (this project may be defunct). PIA studies for the authorized Mainstream Trakas and Beaufort West WEFs as well as the Lombardskraal Renewable Energy Facility and the Heuweltjies WEF have been undertaken by the present author (Almond 2018, 2020a, 2022d, 2022e). In addition, there are the proposed Koup 1 and 2 WEF projects to the west of the N12 as well as the three proposed ABO Kwagga 1 to Kwagga 3 WEFs further to the east, for all of which palaeontological heritage impact assessments have been conducted by the present author (Almond 2021d, 2021e, Almond 2021a-c, 2022c). A number of further wind and solar renewable energy projects have been proposed on the southern outskirts of Beaufort West but these largely lie outside the 35 km cut-off radius applied here. Relevant published palaeontological literature for the region has also been considered (*e.g.* Day & Rubidge 2014, Rubidge & Day 2020, Day & Rubidge 2020). This cumulative impact assessment applies only to the construction phases of the renewable energy developments, since significant additional impacts on palaeontological heritage during the planning, operational and de-commissioning phases are not anticipated.

It should be emphasized that, in the case of palaeontological heritage, it only makes sense to consider cumulative impacts on *comparable fossil assemblages* present in the same rock units (groups, formations, members *etc*) that are represented in the present study area as well as in the broader study region. For example, impacts on Mid-Palaeozoic aquatic fossil invertebrates in the Cape Supergroup that crops out in the Cape Fold Mountains to the south of the present study area are not directly relevant to - or cannot be reasonably weighed against - impacts on Middle Permian fossil assemblages of terrestrial vertebrates in the Lower Beaufort Group that is represented in the present study area. The analysis in Table 5 is therefore restricted to considering cumulative impacts on fossil heritage preserved within rock units and fossil assemblages that are represented in the Kraaltjies WEF and associated Infrastructure project area as well as in nearby WEF and solar project areas – specifically the Abrahamskraal Formation *plus* the lower part of the Teekloof Formation (*viz.* upper *Tapinocephalus* Assemblage Zone). Since potentially fossiliferous, consolidated Late Caenozoic alluvial deposits will normally not be impacted in WEF developments because they usually lie along well-buffered drainage lines, they are not considered for the purpose of this analysis.

In all the strictly *relevant* field-based Karoo palaeontological studies listed above the palaeontological sensitivity of the project area and the palaeontological heritage impact significance for the developments concerned has been rated as *medium* to *low*. In all cases it was concluded by the author that, despite the

undoubted occurrence of scientifically-important fossil remains (notably fossil vertebrates, petrified wood), the overall impact significance of the proposed developments was medium to low because the probability of significant impacts on *scientifically important, unique or rare fossils* was limited. While fossils do indeed occur within most of the formations present, they tend to be sparsely distributed – especially as far as fossil vertebrates are concerned - while the great majority represent common forms that occur widely within the outcrop areas of the rock units concerned. Important exceptions include rare, semi-articulated skeletal remains of therapsids and pareiasaur reptiles as well as well-preserved dinocephalian and dicynodont skulls of biostratigraphic significance from the *Tapinocephalus* Assemblage Zone.

Anticipated cumulative impacts of the known renewable energy projects proposed or authorised for the margins of the Great Karoo region to the south of Beaufort West are assessed as *NEGATIVE MEDIUM* without mitigation. Overall impact significance may fall to NEGATIVE LOW with full mitigation since impacts will then occur at a lower intensity and will be partially offset by valuable new scientific data. The analysis only applies *provided that* all the proposed monitoring and mitigation recommendations made for all these various projects are followed through (*N.B.* This is inherently unpredictable, and, sadly, unlikely). Unavoidable residual negative impacts may be partially offset by the improved understanding of Karoo palaeontology resulting from appropriate professional mitigation. This is regarded as a *positive* impact for Karoo palaeontological heritage.

In conclusion, the cumulative impacts on local fossil heritage anticipated for the various renewable energy projects in the southern Great Karoo margins region due south of Beaufort West – including the proposed Kraaltjies WEF and associated Infrastructure – fall within acceptable limits, *provided that* all recommended mitigation recommendations for these projects are consistently and fully implemented.

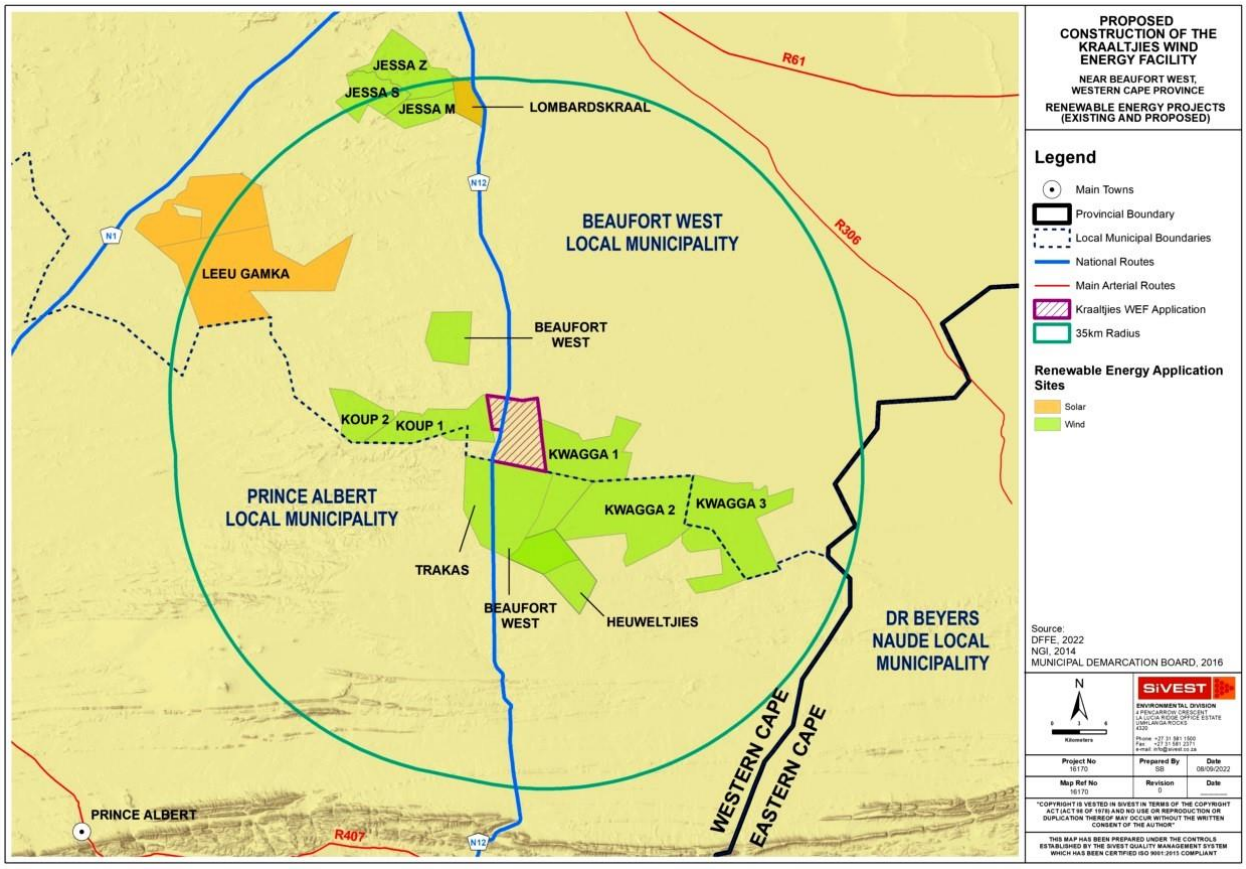

Figure 75: Map showing project areas for authorized and proposed renewable energy projects within a 35 km radius of the Kraaltjies WEF and associated infrastructure project area (Image provided by SiVEST).

Table 1: Renewable energy developments proposed within a 35km radius of the Kraaltjies WEF and associated Infrastructure application site.

Project	DEA Reference No	Technology	Capacity	Status of Application / Development
Proposed Beaufort West Wind Farm	12/12/20/1784/1	Wind	140MW	Approved
Proposed Trakas Wind Farm	12/12/20/1784/2	Wind	140MW	Approved
Proposed Wind and Solar Facility on the Farm Lombardskraal 330	14/12/16/3/3/2/406	Solar	20MW	EIA in Process
Proposed Leeu Gamka Solar Power Plant	12/12/20/2296	Solar	-	Withdrawn/ lapsed
Proposed Heuweltjies WEF	TBA	Wind	240MW	EIA in Process
Kwagga WEF 1	Pending	Wind	279 MW	EIA in Process
Kwagga WEF 2	Pending	Wind	341 MW	EIA in Process
Kwagga WEF 3	Pending	Wind	204.6 MW	EIA in Process
Koup 1 WEF	TBA	Wind		EIA in Process
Koup 2 WEF	TBA	Wind	140 MW	EIA in Process

Table 2: Assessment of paleontological heritage impacts for the proposed Kraaltjies Wind Energy Facility (Construction Phase)

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	3	4	2	4	2	28	-	M	- Immediate assessment of footprint areas before construction by palaeontologist - Implementation of Chance finds protocol	1	2	4	2	4	1	13	-	L

Table 3: Assessment of impacts for the No Go Option

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS	S		E	P	R	L	D	I / M	TOTAL	STATUS	S
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to natural weathering and erosion, farming activities and possible illegal fossil collection.	1	2	4	2	4	1	13	_	M	N/A									N/A

Table 4: Assessment of cumulative impacts for the Kraaltjies WEF and associated Infrastructure and other renewable energy developments in the region.

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	4	4	3	4	2	32	-	M	- Immediate assessment of footprint areas before construction by palaeontologist - Implementation of Chance finds protocol	1	2	4	2	4	1	13	-	L

7.5 Overall Impact Rating

Overall impact ratings (including all phases of the developments) for the Kraaltjies WEF and associated Infrastructure project are provided in Tables 6 & 7 below. The significance of relevant cumulative impacts is assessed in Table 8. Recommended monitoring and mitigation measures for these developments are outlined in more detail in Section 8 of this report.

Table 5: Overall impact rating for the Kraaltjies WEF project

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	3	4	3	4	2	28	-	M	- Immediate assessment of footprint areas before construction by palaeontologist - Implementation of Chance finds protocol	1	2	4	2	4	1	13	-	L

Table 7: Overall cumulative impact rating for the Kraaltjies WEF and associated Infrastructure project

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Fossil heritage resources	Disturbance, damage or destruction of fossils at or beneath the ground surface due to surface clearance and bedrock excavations	1	4	4	3	4	2	32	-	M	- Immediate assessment of footprint areas before construction by palaeontologist - Implementation of Chance finds protocol	1	2	4	2	4	1	13	-	L

8. COMPARATIVE ASSESSMENT OF ALTERNATIVES

8.1 Kraaltjies WEF

A comparable NEGATIVE MEDIUM impact significance (without mitigation), as assessed in Table 2 applies equally to all project infrastructure alternatives and layout options under consideration that are outlined in Section 3.3 of this report. This includes the various site options for the on-site substation (including the on-site substation, construction laydown area, O&M buildings, BESS). Given their very similar geological - and hence palaeontological - contexts, there are no preferences on palaeontological heritage grounds for any specific layout among the various options under consideration (See **Figure 3**, Figures A1.1 to A1.3).

Table 6: Comparative assessment of WEF Substation layout options

Alternative	Preference	Reasons (incl. potential issues)
SUBSTATION SITE ALTERNATIVES		
Substation Option 1	No preference	Comparable geology and palaeontology to alternative.
Substation Option 2	No preference	Comparable geology and palaeontology to alternative.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact / result in a positive impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

9. PROPOSED MONITORING AND MITIGATION: INPUT TO EMPR

Only a small number of new fossil sites have recorded in the vicinity of the Kraaltjies WEF and associated Infrastructure project area (Section 5, Appendix 1). It is noted that (1) the majority of these fossil sites – including the only High Sensitivity area identified here (red polygon in satellite map Appendix 1, Figure A1.3) - lie well away from the proposed infrastructure footprints, (2) most of them are rated as being of low scientific or conservation significance (See table in Appendix 1), (4) most of the scientifically valuable material has already been professionally sampled or collected, while (3) all of the sites can be mitigated, if necessary, through professional palaeontological collection during the construction phase. ***The distribution of fossil sites therefore has no influence on the proposed layout of the WEF or associated Infrastructure.***

A summary of recommended monitoring and mitigation for the Kraaltjies WEF project is provided in Table 9 below.

If (*and only if*) the WEF receives Environmental Authorization, the approved layout of the WEF and associated Infrastructure must be, immediately pre-construction, cross-checked by a qualified palaeontological specialist to determine what level of additional palaeontological surveying, monitoring or mitigation is necessary for these projects, if any. Should a palaeontologicalheritage study of selected, potentially sensitive and previously unsurveyed sectors of the authorised footprint be recommended at this stage, this should involve the recording and judicious collection by a professional palaeontologist of valuable fossil material as well as relevant geological data (e.g., on stratigraphic context, preservation style / taphonomy) within or close to (within ~10 m) the project footprint in the Pre-Construction Phase. Since mitigation through professional recording and collection is almost invariably feasible for fossil sites. During the construction phase, the Chance Fossil Finds Protocol summarised in Appendix 2 should be fully implemented.

The Environmental Control Officer (ECO) / Environmental Site Officer (ESO) responsible for the WEF and associated Infrastructure developments should be made aware of the possibility of important fossil remains (vertebrate bones, teeth, petrified wood, plant-rich horizons *etc.*) being found or unearthed during the construction phase of the development. Monitoring for fossil material of all major surface clearance and deeper (>1m) excavations by ECO / ESO on an on-going basis during the construction phase is therefore recommended. Significant fossil finds should be safeguarded and reported at the earliest opportunity to Heritage Western Cape for recording and sampling by a professional palaeontologist (Contact details: Heritage Western Cape. 3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 Email: ceoheritage@westerncape.gov.za).

The qualified palaeontologist responsible for the mitigation work on discovered fossils will need to submit beforehand a Work Plan for approval by Heritage Western Cape (HWC) and, following completion of mitigation, a Mitigation Report must be submitted to HWC for consideration. All fieldwork and reporting should meet the standards of international best practice as well as those developed for PIA reports by SAHRA (2013) and Heritage Western Cape (2021). Fossil material collected must be safeguarded and curated within an approved palaeontological repository (*e.g.* museum or university collection) with full collection data. **These recommendations must be included within the EMPrs for the Kraaltjies WEF and the associated infrastructure development.**

Table 9: Recommended monitoring and mitigation for the Kraaltjies WEF project

PALAEONTOLOGICAL HERITAGE MITIGATION & MANAGEMENT					
Impact/Aspect	**Mitigation/Management Actions**	***Responsibility***	***Methodology***	**Mitigation/Management Objectives and Outcomes**	***Frequency***
CONSTRUCTION PHASE					
Disturbance, damage or destruction of fossil remains preserved at or below the ground surface through site clearance of bedrock excavations.	Assessment of footprint areas immediately before construction commence. Monitoring of substantial, deeper excavations (> 1m)	Specialist palaeontologist appointed by developer ECO / ESO	Assessment of footprint areas immediately before construction commences in sensitive sectors with recording and judicious collection of fossil material where discovered. Curation of fossils and site data within an approved repository (museum / university palaeontological collection) 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 Heritage Western Cape for potential mitigation.	Before and 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

10. SUMMARY & CONCLUSIONS

10.1 Summary of Findings

The proposed Kraaltjies WEF and associated Infrastructure project area is underlain by continental (fluvial / lacustrine) sediments of the Abrahamskraal Formation and lowermost Teekloof Formation (Lower Beaufort Group, Karoo Supergroup) which are of late Middle Permian age. These bedrocks contain sparse, unpredictable to locally concentrated vertebrate fossils as well as rare trace fossils (*e.g.,* tetrapod trackways and burrows, lungfish burrows) and plant material of scientific and conservation value. Comparatively few new fossil vertebrate sites - most notably a partial, articulated skeleton of a therocephalian carnivore - have been recorded within the WEF project area during the short site visit, while several more sites have previously been mapped in the vicinity during recent palaeontological surveys of adjoining WEF project areas. The few new palaeontological sites, together with their sedimentological context, provide important data for on-going research into the pattern and causes of the Middle Permian Mass Extinction Event on land around 260 million years ago. All of the recorded fossil sites lie *outside* the WEF and associated Infrastructure project footprint.

Only one small palaeontological Very High Sensitivity area – located towards the southern edge of Farm Brits Eigendom No 374/25 and characterized by *in situ* therapsid skeletal material and abundant fish remains - has been identified within the project area (see red polygon, including a buffer zone, in satellite image Appendix 1, Figure A1.2). This High Sensitivity area lies *outside* the WEF and associated Infrastructure footprint. Since all known fossil sites can be readily mitigated – if necessary – through professional recording and collection of fossil material in the pre-construction phase, no recommendations for micro-siting of infrastructure such as wind turbine, pylon positions or access roads are therefore made here. There are no preferences on palaeontological heritage grounds for specific site options for the WEF on-site substation and construction laydown area, given their similar geological and palaeontological context.

The proposed Kraaltjies WEF and associated Infrastructure development is assigned a similar overall impact significance rating (Construction Phase) of NEGATIVE MEDIUM without mitigation and NEGATIVE LOW following mitigation. Residual negative impacts may be partially offset by improvements to the local palaeontological database as a result of professional mitigation of chance fossil finds. No significant further impacts on fossil heritage resources are anticipated in the planning, operational and decommissioning phases. The No-Go Option is likely to have a neutral impact significance; fossils will continue to be exposed and destroyed by natural weathering processes while the positive benefits of professional mitigation (*viz*. improved palaeontological database) will be lost. Anticipated cumulative impacts in the context of several planned or authorized renewable energy projects in the region are assessed as NEGATIVE MEDIUM before mitigation and NEGATIVE LOW after mitigation. These cumulative impacts fall within acceptable limits.

Recommended mitigation for the WEF and associated Infrastructure project comprises:

If (*and only if*) the WEF receives Environmental Authorization, the approved layout of the WEF and associated Infrastructure must be, immediately pre-construction, cross-checked by a qualified palaeontological specialist to determine what level of additional palaeontological surveying, monitoring or mitigation is necessary for these projects, if any. Should a palaeontological heritage study of selected, potentially sensitive and previously unsurveyed sectors of the authorised footprint be recommended at this stage, this should involve the recording and judicious collection by a professional palaeontologist of valuable fossil material as well as relevant geological data (e.g., on stratigraphic context, preservation style / taphonomy) within or close to (within ~10 m) the project footprint in the Pre-Construction Phase. Since mitigation through professional recording and collection is almost invariably feasible for fossil sites. During the construction phase, the Chance Fossil Finds Protocol summarised in Appendix 2 should be fully implemented.

The qualified palaeontologist responsible for any Construction Phase mitigation work will need to submit beforehand a Work Plan for approval by Heritage Western Cape (HWC) and, following completion of mitigation, a Mitigation Report must be submitted by the specialist to HWC for consideration.

The proposed WEF and associated Infrastructure development is not fatally flawed and, on condition that the recommended mitigation measures are included within the relevant EMPr and implemented in full, there are no objections on palaeontological heritage grounds to the granting of Environmental Authorisation for the Kraaltjies WEF project.

10.2 Conclusions and Impact Statement

In terms of palaeontological heritage resources, the proposed Kraaltjies WEF and associated infrastructure development is assigned a similar overall impact significance rating (Construction Phase) of NEGATIVE MEDIUM without mitigation and NEGATIVE LOW following mitigation. Residual negative impacts may be partially offset by improvements to the local palaeontological database as a result of professional mitigation of chance fossil finds. No significant further impacts on fossil heritage resources are anticipated in the planning, operational and decommissioning phases. The No-Go Option is likely to have a neutral impact significance. Anticipated cumulative impacts in the context of several planned or authorized renewable energy projects in the region are assessed as NEGATIVE MEDIUM without mitigation and NEGATIVE LOW after mitigation. These cumulative impacts fall within acceptable limits.

The proposed WEF and associated infrastructure development is not fatally flawed and, on condition that the recommended mitigation measures are included within the relevant EMPr and implemented in full, there are no objections on palaeontological heritage grounds to the granting of Environmental Authorisation for the Kraaltjies WEF project.

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12. ACKNOWLEDGEMENTS

I am grateful to Ms Michelle Guy of the SiVEST Environmental Division as well as Mnr Wouter Fourie of PGS Heritage for commissioning this study as well as for providing the necessary project information. Ms Niki Mann of PGS is thanked for helpful editorial input. The landowners concerned with the WEF study area are thanked

for access permission to their property. Professor Bruce Rubidge and Dr Marc van den Brandt of the Evolutionary Studies Institute, Wits University, are both thanked for helpful discussions on Karoo palaeontology as well as for professional sampling and evaluation of new fossil material within the WEF project area. Finally, the companionship in the field, substantial palaeontological contributions as well as logistical backup kindly provided by Ms Madelon Tusenius and Ms Hedi Stummer are all highly appreciated, as always.

Declaration of Independence

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

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

APPENDIX 1: PALAEONTOLOGICAL SITE DATA (Nov. 2022): Kraaltjies WEF project area on Farm Brits Eigendom No 374, Portions 10 and 25

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.*

Given the structural complexity of the project area (folding, faulting), the fossils recorded are not assigned to a specific member of the Abrahamskraal Formation. Assignment of fossils close to the Abrahamskraal Formation / Teekloof Formation contact is only provisional since this boundary is not well defined here. Approximately 80 bedrock exposures were examined during the course of the site visit by three experienced heritage professionals, with fossils recorded at approximately 30 sites. Fossil sites are clearly only sparsely distributed in this region. Fossil sites are mapped in the context of the proposed final layouts of the Kraaltjies Wind Facility and associated infrastructure on satellite images in Figures A1.1 to A1.2 below. The fossil sites tabulated and mapped here obviously do not (and cannot) represent *all* fossil sites at surface within the 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 Chance Fossil Finds Protocol is appended to this report.

Loc	GPS data	Comments
064	S32° 54' 19.3" E22° 34' 41.8"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Palaeosol horizon marked by abundant, weathering-out ferruginous carbonate concretions. **Two fragmentary, indeterminate bones** enclosed within palaeocalcrete concretions. Proposed Field Rating IIIC – no mitigation necessary.
065	S32° 54' 18.9" E22° 34' 44.4"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Small palaeocalcrete concretions containing (1) **poorly-preserved skull / snout with tusks, (2) partial snout with various sized teeth – possibly of therocephalian therapsid (*cf Pristerognathus*).** Proposed Field Rating IIIB. Lies well outside project footprint, so no mitigation necessary
066	S32° 54' 25.2" E22° 34' 57.6"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Disarticulated, scattered **postcranial remains of medium-sized tetrapod** (probably therapsid), including limb bones, vertebrae, ribs, possible girdles *etc*., partially still *in situ* within siltstone. Thin (few cm thick horizon) of greyish-green, brownish-weathering, concretionary carbonate-cemented lacustrine mudrock containing lag concentration of abundant tiny **fish remains,** including bones and dark, shiny, phosphatic ornamented scales of **palaeoniscoid bony fish** *cf. Namaichthys*, possibly also mudflake intraclasts. Proposed Field Rating IIIB. Lies well outside project footprint, so no mitigation necesary
067	S32° 54' 25.0" E22° 34' 59.7"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Good hilltop and slope exposure of grey-green and minor purple brown overbank mudrocks with ferruginous carbonate pedocrete horizons, silicified gypsum crystal crack infills, crevasse splay sandstones, thin channel sandstone. Pervasive E-W cleavage / fracture sets within bedrocks. Mixed grey-green and purple-brown mudrock horizons with intense loading of sandstone units– possibly lacustrine.

		Skull and incomplete, semi- articulated postcrania (limb bones, pelvis *etc*) of a **medium-sized, therocephalian (**predatory theriodont therapsid) *in situ*, enclosed in brownish concretionary pedogenic calcrete within overbank mudrocks. Snout and several further postcranial fragments of skeleton found in float in stream gulley downslope to the north (see following waypoint). Proposed Field Rating IIIB. Specialist recording and collection necessary if threatened by WEF development but currently lies well outside development footprint.
068	S32° 54' 24.6" E22° 34' 59.6"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Snout of therocephalian** above and several further postcranial fragments of skeleton found in float in stream gulley downslope to the north. Proposed Field Rating IIIB. Snout collected. Specialist recording and collection of other remains necessary if threatened by WEF development but currently lies well outside development footprint.
069	S32° 54' 24.2" E22° 34' 58.6"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Fragment of **large long bone or girdle** in float. Proposed Field Rating IIIC. Specialist recording and collection necessary if threatened by WEF development but currently lies well outside development footprint.
070	S32° 54' 24.1" E22° 34' 58.7"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Two further **postcranial fragments (limb bones/girdle) and vertebral centrum** of large-bodied tetrapod in float. Proposed Field Rating IIIC. Specialist recording and collection necessary if threatened by WEF development but currently lies well outside development footprint.
073	S32° 54' 25.2" E22° 35' 00.4"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Isolated **chunk of fossil bone** of large-bodied tetrapod in float. Proposed Field Rating IIIC. Specialist recording and collection necessary if threatened by WEF development but currently lies well outside development footprint.
077	S32°54'6.97"S E22°36'28.83"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Two **small blocks of fossil bone** *ex situ* among pale greenish tuffite-rich, orange-patinated surface gravels. *In situ* tuffite overlain by pedogenic carbonate horizon (possible source of bones). Proposed Field Rating IIIC – no mitigation necessary.
083	S32° 52' 54.5" E22° 35' 16.5"	Portion 25 of the Farm Brits Eigendom No 374. Poortjie Member (lower Teekloof Fm.) **Poorly-preserved tetrapod skull** enclosed within pedogenic carbonate nodule in float. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
086	S32° 52' 59.5" E22° 35' 03.9"	Portion 25 of the Farm Brits Eigendom No 374. Poortjie Member (lower Teekloof Fm.) Laterally-persistent horizon of ferruginous carbonate pedogenic calcrete. Fragmentary **small fossil skull with longitudinally-ridged tusk (?) and additional tiny teeth** preserved in float within concretion. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
089	S32° 52' 55.0" E22° 33' 37.8"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Small dicynodont skull with articulated lower jaw**, broad intertemporal region within pedogenic calcrete concretion. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.

090	S32° 53' 10.7" E22° 33' 27.3"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Unidentified (postcranial or cranial) bone** material of large-bodied tetrapod within pedogenic concretion in float. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
094	S32° 51' 40.1" E22° 35' 06.8"	Portion 10 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Postcrania (incl. ribs, limb-bones) of small-bodied tetrapod** within concretion among float. Proposed Field Rating IIIC – no mitigation necessary.
096	S32° 51' 40.5" E22° 35' 02.3"	Portion 10 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Small tetrapod skull, probably dicynodont**, preserved *in situ* within palaeocalcrete concretion in hackly-weathering mudrocks. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
100	S32° 51' 29.9" E22° 33' 15.2"	Portion 10 of the Farm Brits Eigendom No 374. Kaatjie se Kop. Uppermost Abrahamskraal Fm or lower Poortjie Member (Teekloof Fm). **Small, unidentifiable rolled fossil bone fragments** within a calcrete concretion, surface float on N slopes of Kaatjie se Kop. Proposed Field Rating IIIC – no mitigation necessary.
101	S32° 51' 29.1" E22° 33' 17.9"	Portion 10 of the Farm Brits Eigendom No 374. Kaatjie se Kop. Uppermost Abrahamskraal Fm or lower Poortjie Member (Teekloof Fm). Ferruginous carbonate concretion containing **numerous fragments of spongy bone** – *possibly* weathered / sun-cracked postcranial remains of large tetrapod. Proposed Field Rating IIIC – no mitigation necessary.
104	S32° 51' 46.7" E22° 33' 02.6"	Portion 10 of the Farm Brits Eigendom No 374. Uppermost Abrahamskraal Fm or lower Poortjie Member (Teekloof Fm). **Small dicynodont skull** with broad intertemporal region embedded in a calcrete concretion within overbank mudrocks. Proposed Field Rating IIIB. Specimen collected – no mitigation necessary.
110	S32° 51' 30.1" E22° 34' 51.7"	Portion 10 of the Farm Brits Eigendom No 374. Uppermost Abrahamskraal Fm or lower Poortjie Member (Teekloof Fm). **Weathered bone chunks (probably unidentifiable) of large-bodied tetrapod** within 2 calcrete concretions in float. Proposed Field Rating IIIC – no mitigation necessary.
111	S32° 51' 29.3" E22° 34' 59.2"	Portion 10 of the Farm Brits Eigendom No 374. Uppermost Abrahamskraal Fm or lower Poortjie Member (Teekloof Fm). **Short, globular skull with articulated lower jaw of small-bodied dicynodont**, lying right side-up, enclosed within calcrete concretion within grey-green overbank mudrocks exposed in river bed. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
112	S32° 51' 22.1" E22° 35' 01.7"	Portion 10 of the Farm Brits Eigendom No 374. Mudrock package within Poortjie Member. **Small dicynodont skull** exposed in oblique dorso-lateral view, embedded in grey-green overbank siltstones. Proposed Field Rating IIIB. Specimen collected – no mitigation necessary.
114	S32° 50' 47.3" E22° 34' 43.6"	Portion 10 of the Farm Brits Eigendom No 374. Mudrock package within Poortjie Member. **Small, poorly preserved skull (probably small dicynodont with articulated lower jaw)** embedded within grey-green overbank mudrocks. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
115	S32° 50' 34.8" E22° 35' 21.6"	Portion 10 of the Farm Brits Eigendom No 374. Probably uppermost Abrahamskraal Fm.

		3 cm wide, **strap-shaped fossil structure – *possibly* an invertebrate burrow** – within grey-green overbank mudrocks locally with dark, pearly phosphatic sheen. Proposed Field Rating IIIC – no mitigation necessary.
116	32°50'39.21"S 22°35'58.24"E	Portion 10 of the Farm Brits Eigendom No 374. Probably uppermost Abrahamskraal Fm. Extensive grey-green mudrock exposure with ***possible* sandstone lungfish burrow cast (equivocal)** – elliptical cross-section, c. 11 cm max. diameter. Proposed Field Rating IIIC – no mitigation necessary.
117	S32° 50' 38.8" E22° 35' 58.2"	Portion 10 of the Farm Brits Eigendom No 374. Probably uppermost Abrahamskraal Fm. **Small dicynodont skull with articulated lower jaw** embedded in calcrete concretion in surface float. Proposed Field Rating IIIB. Specimen collected – no mitigation necessary.
138	S32° 54' 24.4" E22° 34' 58.6"	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Two **fragmentary, highly weathered bones of sizeable tetrapod** (pareiasaur or dinocephalian) in float. Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
155	32°54'24.48"S 22°34'58.21"E	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Small *in situ* dicynodont skull** (probably *Diictodon*). Proposed Field Rating IIIB – specialist recording and collection necessary if threatened by WEF development.
156	32°54'24.67"S 22°34'58.13"E	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Concentration of small (2-3 cm long), **ellipsoidal, dark, shiny grey coprolites or phosphatic concretions** within green-grey mudrocks. Proposed Field Rating IIIB. Specimens (*c*.12) collected – no mitigation necessary.
159	32°54'26.42"S 22°35'0.09"E	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Two **robust teeth (*c*. 2.5 cm long) of a dinocephalian therapsid** in float. **Scatter of small to medium-sized, fragmentary bone chunks of large-bodied tetrapod (probably also dinocephalian).** Proposed Field Rating IIIB. Teeth collected. No mitigation of remaining material necessary.
160	32°54'27.12"S 22°35'0.24"E	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. **Scatter of small to medium-sized, fragmentary bone chunks of large-bodied tetrapod (probably also dinocephalian).** Proposed Field Rating IIIB. No mitigation of remaining material necessary.
162	32°54'25.52"S 22°34'59.07"E	Portion 25 of the Farm Brits Eigendom No 374. Upper Abrahamskraal Fm. Possible but equivocal **sandstone casts of tetrapod burrows** within hackly-weathering dark grey overbank mudrocks with gypsum-infilled desiccation cracks. Proposed Field Rating IIIB. No mitigation necessary.

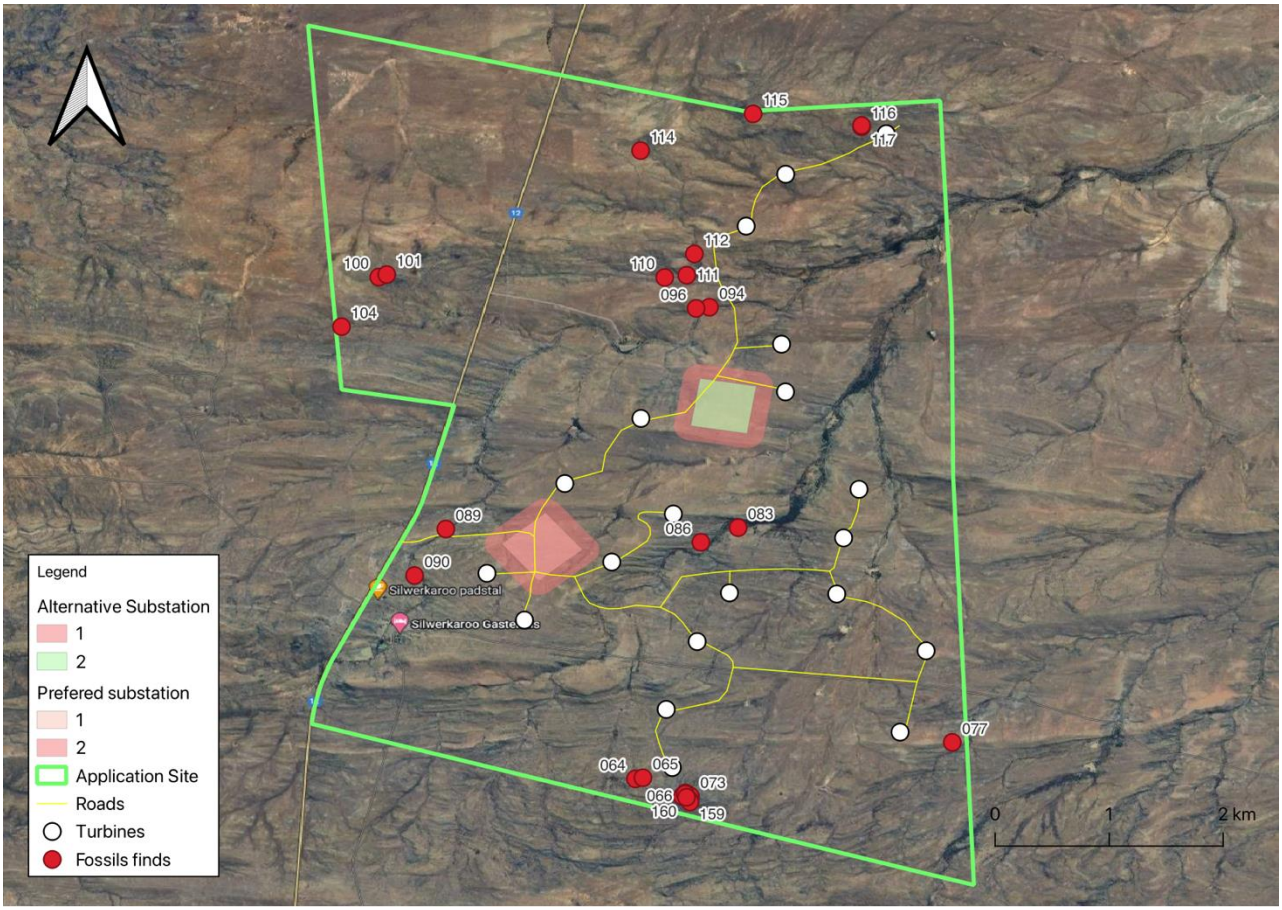

Figure A1.1: Google Earth© satellite image of the Kraaltjies WEF and associated infrastructure project area (orange polygon), showing numbered fossil sites (green numbered squares). Many of the fossil sites are protected within standard environmental buffer zones along drainage lines and none are threatened by any of the proposed infrastructure options depicted here. Only one palaeontological heritage High Sensitivity area has been defined within the WEF and Infrastructure project area (red arrow; see following figure). Well-preserved, scientifically important fossils are sparse and known or chance fossil finds can normally be effectively mitigated through professional recording and collection during the pre-construction phase.

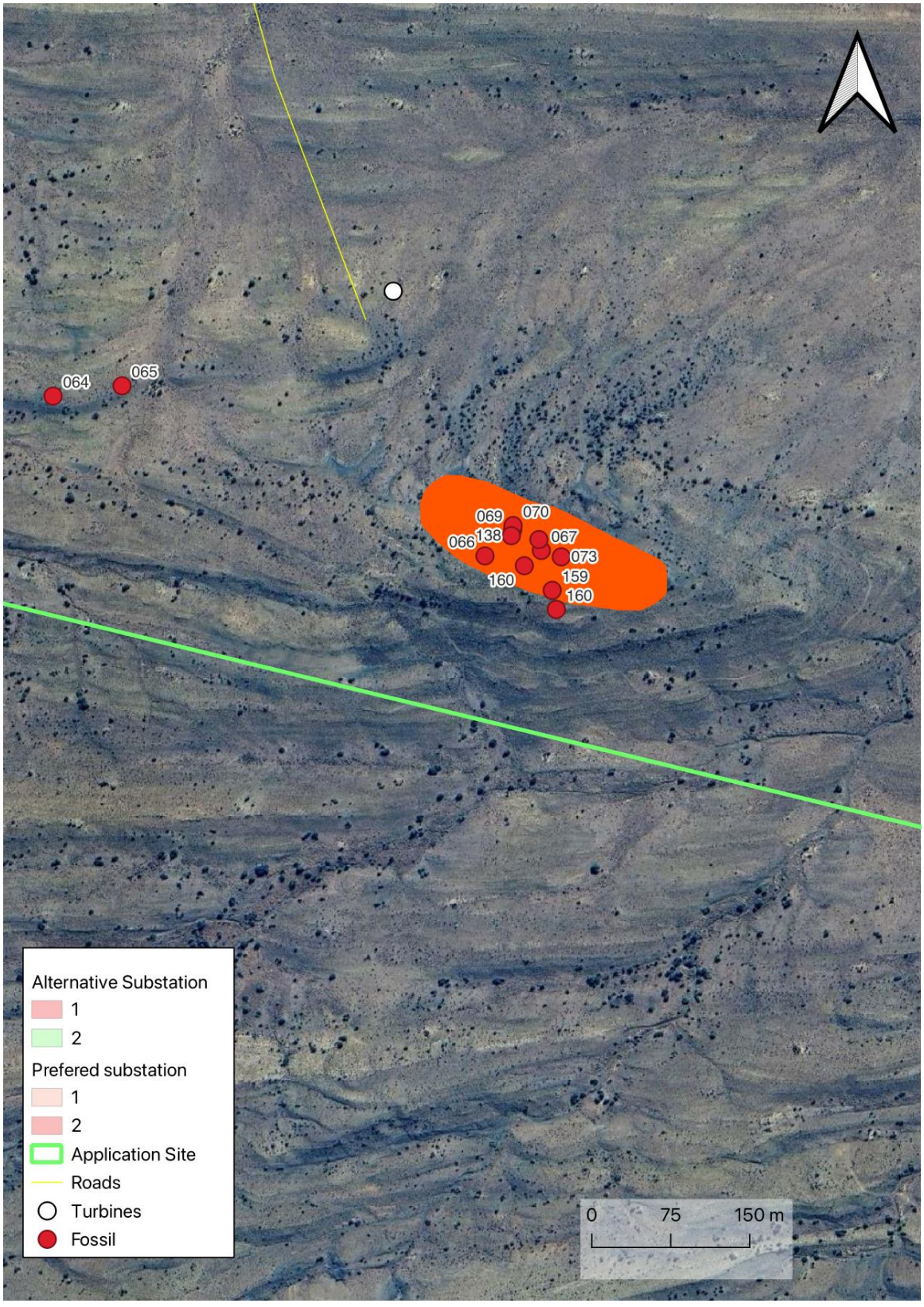

Figure A1.2: Satellite map of the part of the southern margin of Portion 10 of the Farm Brits Eigendom No 374 showing the area of High Palaeosensitivity identified here (small orange polygon). This area lies well outside the WEF and Associated Infrastructure footprints.

<table>
<tr><th colspan="3">APPENDIX 2. CHANCE FOSSIL FINDS PROTOCOL: Kraaltjies Wind Energy Facility & associated Infrastructure near Beaufort West</th></tr>
<tr><td>Province & region:</td><td colspan="2">Western Cape: Prince Albert Local Municipality (Central Karoo District)</td></tr>
<tr><td>Responsible Heritage Resources Agency</td><td colspan="2">Heritage Western Cape (3rd Floor Protea Assurance Building, 142 Longmarket Street, Green Market Square, Cape Town 8000. Private Bag X9067, Cape Town 8001. Tel: 021 483 5959 Email: ceoheritage@westerncape.gov.za)</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Abrahamskraal & Teekloof Formation (Lower Beaufort Group, Middle Permian)
Late Caenozoic colluvium / alluvium / eluvium / soils.</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil vertebrate bones, teeth, invertebrate trace fossils, tetrapod burrows and trackways, petrified wood, plant-rich beds in the Lower Beaufort Group bedrocks.
Fossil mammal bones, teeth, horn cores, freshwater molluscs, plant material, trace fossils in Late Caenozoic sediments.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
• Context – describe position of fossils within stratigraphy (rock layering), depth below surface
• Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g., rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation
• Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Agency for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
• Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g., entire block of fossiliferous rock)
• Photograph fossils against a plain, level background, with scale
• Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
• Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
• Alert Heritage Resources Agency and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Agency, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Agency</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Submit Work Plan for approval by HWC before mitigation commences. Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g., museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Agency. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Agency minimum standards.</td></tr>
</table>

APPENDIX 3: 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)
  For 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.