Palaeontological Impact Assessment for the proposed Canis Energy (Pty) Ltd (Buffalo 2 Solar Park) Renewable Energy Generation Project Farm Vergulde Helm 321 LQ with Overhead Powerlines to the Eskom Medupi Substation, within the Lephalale Local Municipality, Waterberg District Municipality, Limpopo Province

Site Visit Report (Phase 2)

For

Exigent Environmental

17 March 2023

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 34 years research; 26 years PIA studies
Over 350 projects completed.

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Exigent Environmental. Richards Bay and Erasmuskloof, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Canis Energy (Pty) Ltd (Buffalo 2 Solar Park) Renewable Energy Generation Project Farm Vergulde Helm 321 LQ with Overhead Powerlines to the Eskom Medupi Substation, within the Lephalale Local Municipality, Waterberg District Municipality, Limpopo Province

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the potentially fossiliferous Grootegeluk Formation (Equivalent of the Vryheid Formation, Ecca Group, Karoo Supergroup) that could preserve fossil plants of the *Glossopteris* flora. Most of the site is on Quaternary sands that have a lower sensitivity and might have fragmented transported fossils. The site visit and walk through on 11th March 2023 by palaeontologists confirmed that there were NO FOSSILS in the project footprint. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, developer, environmental officer or other designated responsible person once excavations for foundations and infrastructure have commenced.

The impact will only be during the construction phase and pre-mitigation will be low risk and post-mitigation will be low risk. There will be no cumulative impact or risk and there are no no-go areas

Table of Contents

1. Background

Canis Energy (Pty) Ltd, are proposing the development, construction and operation of a renewable energy generation facilities (Photovoltaic Power Plants) and associated infrastructure, and structures on Farm Vergulde Helm 321 LQ, located within the Lephalale Local Municipality, Waterberg District Municipality, Limpopo Province.

This report is part of a project titled "Carina Energy (Pty) Ltd (Buffalo 1 Solar Park) and Canis Energy (Pty) Ltd (Buffalo 2 Solar Park) Renewable Energy Generation Projects on Farms Buffelsjagt 744-LQ and Farm Vergulde Helm 321 LQ with Overhead Powerlines to the Eskom Medupi Substation, within the Lephalale Local Municipality, Waterberg District Municipality.". Department of Forestry, Fisheries and Environment has requested a Scoping Report submission for each Solar Park.

The projects envisage the establishment of a solar power plant with a maximum generation capacity at the delivery point (Maximum Export Capacity) of up to 240 MW. The proposed Buffalo 2 Solar Park will deliver the electrical energy to the Medupi Power station through a new power line of approximately 12 km in length. Two 132 kV feeder bays will be commissioned and equipped at the Eskom Medupi substations.

Table 1: Project details.

Component	Descriptions/dimensions
Height of PV panels	Height of PV panels
Area of the PV Array	Total area of the PV Array: 174.71 ha (considering 625,000 PV modules of 2.795 m^2 each)
Number of inverters required	Each Medium voltage station will be equipped with DC/AC inverters that convert Direct Current (DC) into Alternate Current (AC) at a low voltage (typically 600 V). There will be 100 medium voltage stations of 3.0 MW each throughout the proposed development. PV technology is in constant and rapid evolution, this means that the final choice of the type (e.g. central inverters or string inverters) and model of inverter can be taken at the time of the commission date, on the basis of the availability of inverters of the worldwide market and of the cost-efficiency curve. In any case, the total installed capacity of the inverters (AC side) will be up to 300 MWac.
Area occupied by inverter/transformer stations/substations	There will be 100 medium voltage stations throughout the proposed development. Each will have an area of approximately 30 m^2. Therefore, the combined area of the medium voltage stations will be 3000 m^2
Control rooms	The substation will be equipped with 2 control rooms. The control rooms will have a length of 30 m and a width of 11 m. Therefore, each of the control room will have an area of 330 m^2.
Workshops/Warehouses	Two warehouses / workshops will be constructed within close proximity to the on-site substation and switching station. The three warehouses will have an area of approximately 300 m^2 each: 900 m^2 in total.

Capacity of on-site substations	The on-site 22kV/132kV step-up substation and 132kV switching station will host two 250 MVA 22kV/132kV transformers (one as spare). Should the connection solution proposed by Eskom be at 400kV, additional infrastructure is required - outside the project footprint: For Buffalo 2 Solar Park: one 132kV/400kV step-up substation with high-voltage power transformers, stepping up the voltage to 400kV, and one 400kV busbar with metering and protection devices (switching station), to be built in proximity of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 1).
Area occupied by both permanent and construction laydown areas	Project footprint / fenced area is up to approximately 600 ha per project. Surface area (within the project footprint) will be covered by PV modules, internal roads, MV stations, HV substation and switching station, control buildings, warehouses and Battery Energy Storage System (BESS). The construction camp (temporary) will be up to 20 ha in extent and will correspond to the area used for BESS.
Areas occupied by buildings	Medium-voltage stations occupy a footprint up to 3,000 m^2. On-site substation and switching station occupy a footprint of approx. 11,250 m^2. This area includes the control buildings. Workshop & Warehouse occupy a footprint of approx. 300 m^2 each. In total, 3 warehouses are foreseen. Therefore, the total area occupied by buildings (MV stations, HV substation, Workshop & Warehouse) amounts to approx. 15,150 m^2 (1.5 ha). The Battery Energy Storage Systems (BESS) will be located in the area where the camp site will be for the purpose of the construction phase. This area will be approximately 20ha in size. Should the connection solution proposed by Eskom be at 400kV, additional infrastructure is required - outside the project footprint: For Buffalo 2 Solar Park: one 132kV/400kV step-up substation and switching station, to be built in proximity of the Eskom Medupi Main Transmission Substation (MTS), with a footprint of approx. 22,500 m^2. (Connection Alternative 1)
Length of internal roads	Approximately 40,000 m
Width of internal roads	Up to 8.0 m, with a road reserve up to 13.5 m
Access roads	The project footprints / development areas will have direct access from the District Road Road D1675 towards Steenbokpan
Proximity to the grid connections	• One 132 kV power line (double circuit), approximately 9.8 km long, connecting the on-site 132kV switching station to the 132 kV busbar of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 2).

	Should the connection solution proposed by Eskom be at 400kV, additional infrastructure is required: Buffalo 2 Solar Park: One 132kV/400kV step-up substation with high-voltage power transformers, stepping up the voltage to 400kV, and one 400kV busbar with metering and protection devices (switching station), to be built in proximity of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 1). • One 400 kV power line, approximately 1.3 km long, connecting the on-site 400kV switching station to the 400 kV busbar of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 1).
Height of fencing	3m
Type of fencing	Wire mesh fencing with video-surveillance system
Height of overhead powerlines	132kV: up to 25 m above the ground level 400 kV (if required): up to 45 m above the ground level
Length and width of servitude of 132kV powerlines	One 132 kV power line (double circuit), approximately 9.8 km long, connecting the on-site 132kV switching station to the 132 kV busbar of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 2). Should the connection solution proposed by Eskom be at 400kV: • For Buffalo 2 Solar Park: one 132 kV power line (double circuit), approximately 6.6 km long, connecting the on-site 132kV switching station to the 132 kV busbar of the 132kV/400kV step-up substation and 400kV switching station to be built in proximity of the Eskom Medupi Main Transmission Substation (Connection Alternative 1). Servitude width: 36 m (18 m from each side of the centre line).
Length and width of servitude of 400kV powerlines	Should the connection solution proposed by Eskom be at 400kV, additional infrastructure is required: For Buffalo 2 Solar Park: One 400 kV power line, approximately 1.3 km long, connecting the on-site 400kV switching station to the 400 kV busbar of the Eskom Medupi Main Transmission Substation (Connection Alternative 1). Servitude width: 55 m (27.5 m from each side of the centre line)
On-site substation and switching station	Should the connection solution proposed by Eskom be at 400kV, additional infrastructure is required - outside the project footprint: For Buffalo 1 and 2: one 132kV/400kV step-up substation and switching station, to be built in proximity of the Eskom Medupi Main Transmission Substation (MTS), with a footprint of approx. 22,500 m2 (Connection Alternative 1).
Battery Energy Storage Facility	BESS with a Maximum Export Capacity up to 240 MW each and a 6-hour storage capacity up to 1440 MWh, with a footprint up to 20 ha within the proposed PV plant footprint / fenced area

The proposed development (the Photovoltaic (PV) Power Plants and its connection infrastructure) consists of the installation of the following equipment:

- Photovoltaic modules (mono-crystalline, poly-crystalline, mono or bi-facial modules)
- Mounting systems for the PV arrays (single-axis horizontal trackers or fixed structures) and related foundations
- Internal cabling and string boxes
- Medium voltage stations, hosting DC/AC inverters and LV/MV power transformers
- Medium voltage receiving station(s)
- Workshops & warehouses
- Two on-site 22kV/132kV step-up substations (one per project) with high-voltage power transformers, stepping up the voltage from 22kV (or 33kV) to 132kV, and one 132kV busbar with metering and protection devices (switching station)
- Buffalo 2 Solar Park: one 132 kV power line (double circuit), approximately 9.8 km long, connecting the on-site 132kV switching station to the 132 kV busbar of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 2)
- Should the connection solution proposed by Eskom be at 400kV (Connection Alternative 1):
    - Buffalo 2 Solar Park: one 132 kV power line (double circuit), approximately 6.6 km long, connecting the on-site 132kV switching station to the 132 kV busbar of the 132kV/400kV step-up substation and 400kV switching station to be built in proximity of the Eskom Medupi Main Transmission Substation (Connection Alternative 1)
    - Buffalo 2 Solar Park: one 132kV/400kV step-up substation with high-voltage power transformers, stepping up the voltage to 400kV, and one 400kV busbar with metering and protection devices (switching station), to be built in proximity of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 1)
    - Buffalo 2 Solar Park: One 400 kV power line, approximately 1.3 km long, connecting the on-site 400kV switching station to the 400 kV busbar of the Eskom Medupi Main Transmission Substation (MTS) (Connection Alternative 1)
- An extension of the 132kV and/or 400kV busbar of the Eskom substation(s) may be required
- Battery Energy Storage System (BESS) (one per project), with a Maximum Export Capacity up to 240 MW each and a 6-hour storage capacity up to 1440 MWh, with a footprint up to 20 ha within the proposed PV plant footprint / fenced area
- Electrical system and UPS (Uninterruptible Power Supply) devices
- Lighting system
- Grounding system
- Internal roads
- Fencing of the site and alarm and video-surveillance system
- Water access point, water supply pipelines, water treatment facilities
- Sewage system
- During the construction phase, the site may be provided with additional:
- Water access point, water supply pipelines, water treatment facilities

- Pre-fabricated buildings
- Workshops & warehouses to be removed at the end of construction.
- The connection may also entail interventions on the Eskom grid, according to Eskom's connection requirements/solution.

A Palaeontological Impact Assessment was requested for the Buffalo 1 Solar Park project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit and walkthrough (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 2: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Section 3
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3iii
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	Section 4
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;	Section 3-4
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
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	Section 4

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	Section 8 Appendix A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity 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	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	None
p	A summary and copies of any comments that were received during any consultation process	EAP
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

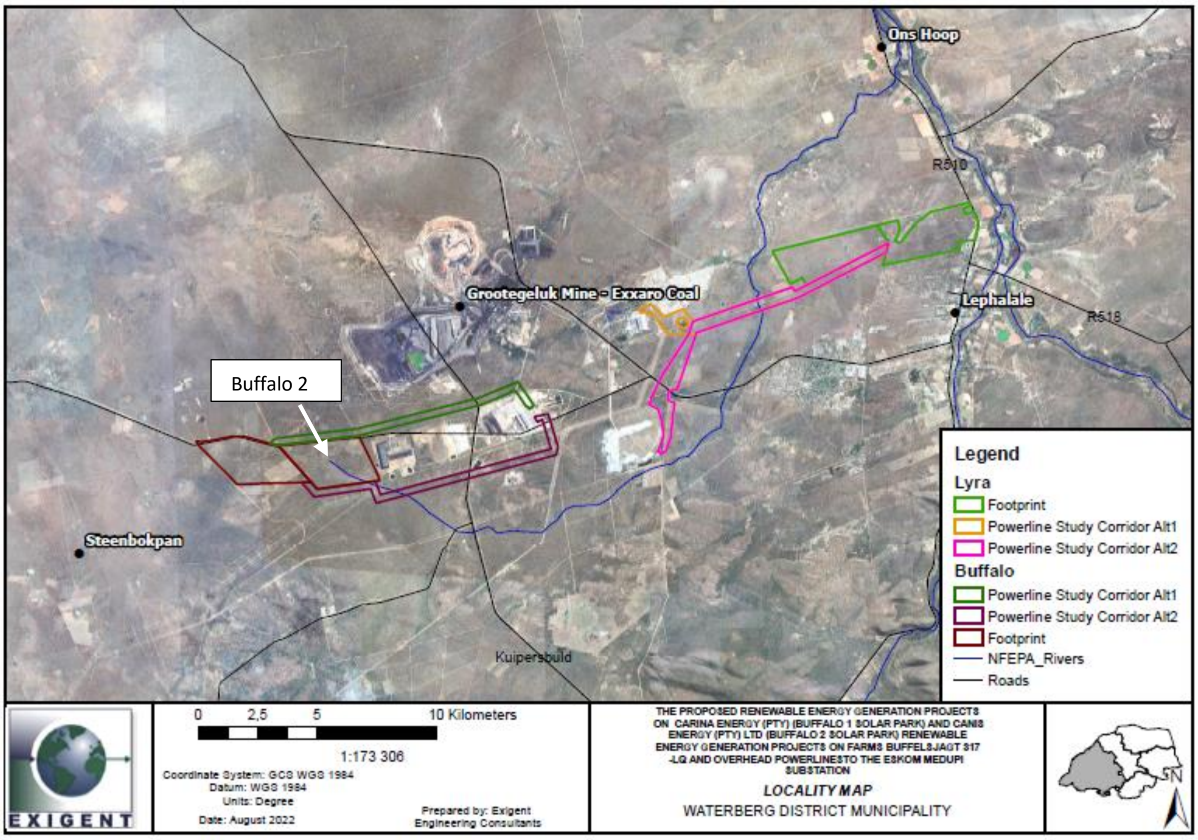

Figure 1: Google Earth map of the proposed complete development showing the relevant landmarks. The Buffalo 2 Solar Park is in the brown polygon. The two alternate grid connection routes are dealt with in the Buffalo 1 Solar Park Report.

Figure 2: Google Earth map for the proposed Buffalo 2 Solar Park on Farm Vergulde Helm 321 LQ, central orange polygon.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases; https://sahris.sahra.org.za/mal/palaeo and Palaeotechnical report for the province.
2. Where necessary, **site visits** by a qualified palaeontologist to verify the palaeosensitivity, locate any fossils and assess their importance, as is the case here;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*possibly applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

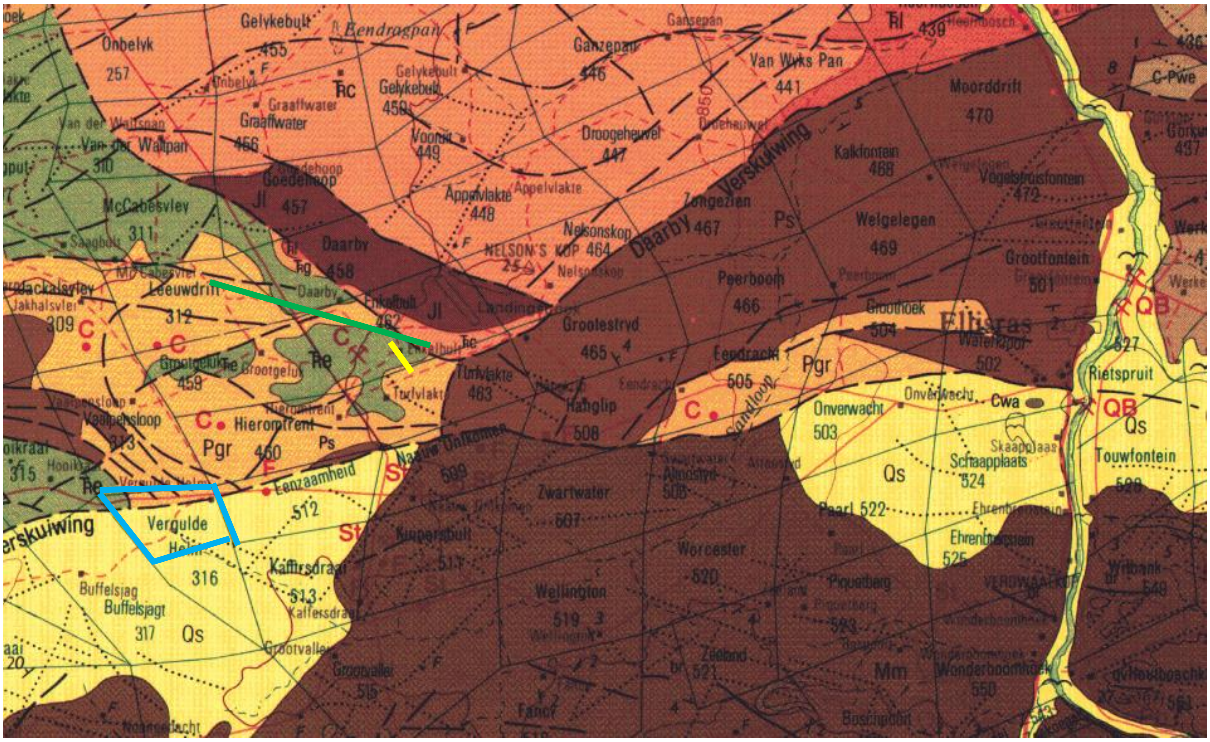

Figure 3: Geological map of the area around the Buffalo 2 Solar Park project area outlined in blue. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2326 Ellisras.

Table 3: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary	Alluvium, sand, calcrete	Quaternary, ca 1.0 Ma to present
Tr-c	Clarens Fm, Stormberg Group, Karoo SG	Fine-grained cream coloured sandstone	Late Triassic
Tr-e	Eendtrgtpan Fm, Stormberg Group, Karoo SG	Variegated shales	Late Triassic
Pgr	Grootgeluk Fm = Vryheid Fm, Ecca Group, Karoo SG	Mudstone, carbonaceous shale, coal	Early Permian
Ps	Swartrand Fm = Pietermaritzburg Fm, Ecca Group, Karoo SG	Shales, mudstones	Early Permian
C-Pwe	Wellington Fm, Dwyka Group, Karoo SG	Mudstone, siltstone, minor grit	Late Carboniferous to Early Permian
Mm	Mogalakwena Fm, Kransberg Sugbroup, Waterberg Group	Sandstone, arenites, rudites, o=pebble washes	2000 – 1700 Ma

The site lies in the Ellisras Basin, an equivalent of the main Karoo basin where the lower Karoo Supergroup strata are exposed. These sediments unconformably overlie the much older Waterberg Group quartzites. Much of the area is overlain by aeolian sands and alluvium, especially along the rivers and streams (Figure 3).

The Palaeoproterozoic rocks of southern Africa occur in Limpopo, Mpumalanga and Gauteng Provinces and extend westwards into Botswana, and occur in three basins. Three main strata are recognised, the Soutspansberg Group, the Waterberg Group and the Blouberg Formation. A number of attempts have been made to correlate the strata in the different basins, the Waterberg Basin, the Soutpansberg Basin and the Middelburg Basin.

The Waterberg Group occurs in the Waterberg and Nylstroom Basins (Barker et al., 2006) and rests unconformably on rocks of the Transvaal Supergroup and the Bushveld Complex. It is overlain by Karoo Supergroup rocks. Three subgroups are recognised throughout the main Waterberg Basin but only the oldest subgroup occurs in the Nylstroom Basin. Different formations are noted in the south, southwest and central areas compared to the North, northeast and central areas according to SACS, (1980). In the northern part the upper Kransberg Subgroup has three formations in its southern part but in the northern part are the **Mogalawena**, Cleremont and Vaalwater Formations (Barker et al., 2006).

The Waterberg Group was deposited between 2000 and 1700 million years ago, well after the Great Oxidation Event (GOE, ca 2.5Ga) so oxygen was available and these shallow water deposits are known as red beds. It has been divided into three subgroups with only the basal group, the Nylstroom Subgroup, occurring in the study area (Figure 3). The Nylstroom and Matlabas Subgroups form a crude upward-fining sequence with rudites and arenites at the base and grading to lutites and well-sorted arenites at the top. The overlying Kransberg Subgroup forms a second, similar, upward-fining sequence in the Waterberg Basin (Barker et al., 2006).

This site occurs in the northern Mogalakwena Formation that is composed of granule-rich lithic arenites and granule rudites with pebble washes and interbedded pebble to cobble rudites (Barker et al., 2006). Palaeocurrents are towards the west-southwest from large braided rivers from highlands in the north-northeast (ibid). The equivalent aged Sandriviersberg Formation represents the more distal facies of the large rivers and the Mogalakwena the more proximal facies.

The **Karoo Supergroup** rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group in the Main Karoo Basin. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled (Johnson et al., 2006).

The Ellisras Basin is a northern outlier of the Main Karoo Basin with equivalent aged rocks but different names. Descriptions of the geology were derived mainly from borehole cores (Brandl, 1996; Johnson et al., 2006) because exposures are very poor. Palynology of the cores and succession has been described by MacRae (1988) but has not been updated.

Nine formations have been recognised (Brandl, 1996; Johnson et al., 2006) and they are from the base upwards the Waterkloof, Wellington, Swartrand, Goedgedacht, Grootegeluk, Eendragtpan. Greenwich, Lisbon and Clarens Formations.

The basal **Waterkloof Formation**, equivalent of the Dwyka Group in the Main Karoo Basin, is composed of diamictite, mudstone, rhythmites and conglomerate, and interpreted as subaqueous outwash deposits that were deposited after the reworking of tills from retreating glaciers (Johnson et al., 2006). The glaciers came from the north and northeast so the mudstones probably represent distal glaciolacustrine deposits (ibid).

The **Wellington Formation** outcrops in the southern part of the Ellisras Basin and is much thicker the farther south it goes. It comprises dark grey horizontally laminated mudstone and siltstone with some sandstone lenses. Higher up the sequence it becomes more silty with coarsening-upward cycles (Johnson et al., 2006). This formation as interpreted as suspension deposits that formed in a large body of standing water.

The **Swartrand Formation** has been divided into three zones on the basis of varying proportions of mudstone, siltstone, sandstone and coals. The lower zone probably represents a delta front that built out from the east, and has no coal seams. The middle zone represents a transgressive phase and is capped by alternating coal seams and mudstones that are interpreted as having been deposited in a glaciolacutrine environment. The upper zone has thin coal seams interspersed with mudstones and sandstones and has been interpreted as channel fill deposits and a northern crevasse-splay deposit. It is the equivalent of the Pietermaritzburg Formation of the Main Karoo Basin.

The **Goedgedagt Formation** is a small section of the **Grootgeluk Formation** and both are considered to be equivalent of the Vryheid Formation with numerous coal seams (Johnson et al., 2006). While the mudstones of the Goedgedagt Formation are believed to have formed as high velocity mudflows in a proglacial environment, the Grootgeluk coal seams formed in a stable tectonic environment where the peats accumulated in poorly drained swamps. These peats were later buried and converted to coal seams (Johnson et al., 2006). This is the most economically important formation in the Ellisras Basin.

Next is the **Eendragtpan Formation** that is composed of sandstones that were deposited in a much drier environment so no coals were formed. These oxidised sands likely were deposited in a well-drained low-energy setting under subaerial conditions (semi-desert).

The **Greenwich Formation** has darker sandstones and minor mudstone lenses and probably represents channel deposits in a braided stream environment (ibid).

The **Lisbon Formation** is finer-grained than the underlying formation and has mudstones and siltstones with some trace fossils, interpreted as fining-upward sequences along extensive floodplains and meandering rivers (Johnson et al., 2006). Some sandstones are aeolian in origin and indicate a drier environment, like the Clarens Formation of the Main Karoo Basin.

Even drier conditions are indicated by the massive palaeo-dunes and ridges of the **Clarens Formation** in the Ellisrus Basin. Small ephemeral rivers may have introduced the minor coarse detrital material while the cross-beds indicate that the palaeo-winds came from the WSW (ibid).

Sands and alluvium of **Quaternary** age cover much of the area. They are the weathered and transported sediments from the older consolidated rocks and sandstones and may have been reworked a number of times so are difficult to date and correlate (Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is two formations. From the SAHRIS map below, the area is indicated as very highly sensitive (red) for the Grootgeluk Formation and moderately sensitive (green) for the Mogalakwena Formation and the Quaternary sands. According to SAHRA rules a site visit must be completed for the very highly sensitive sites (red) so this was done and is reported herein.

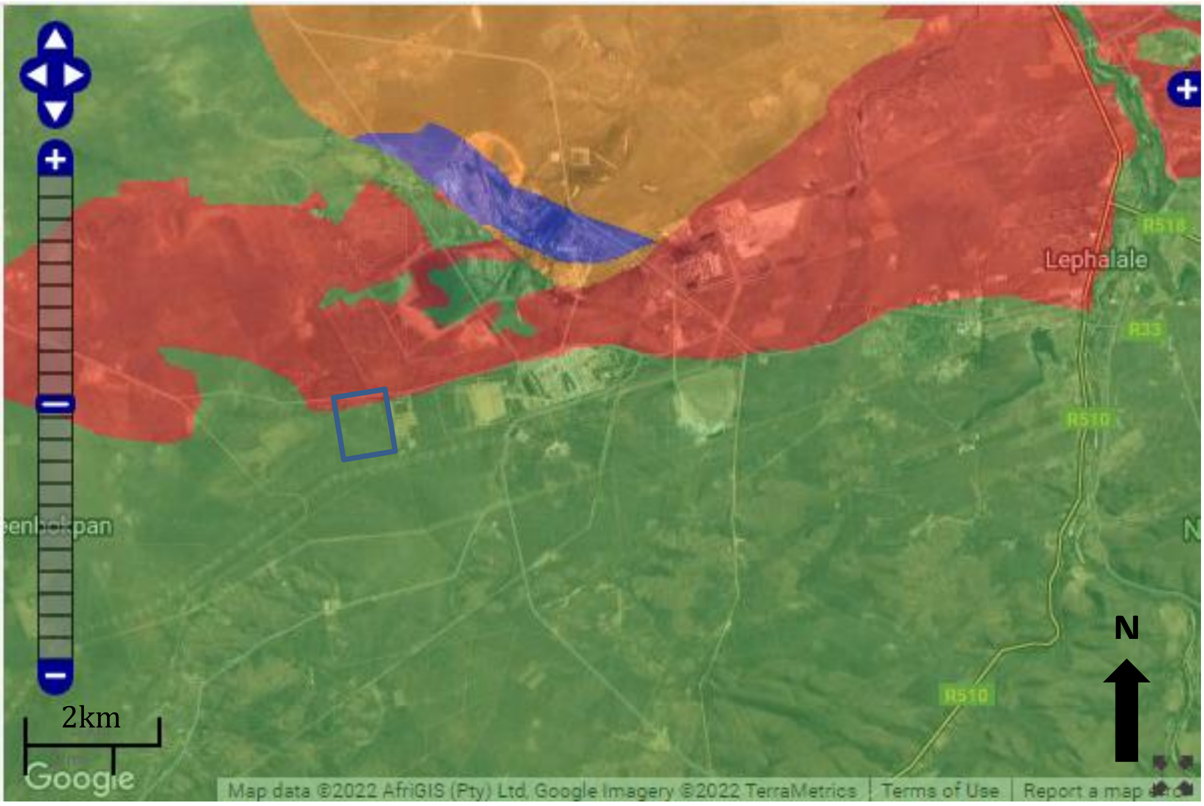

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Buffalo 2 Solar Park shown within the blue rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

In the Grootegelik Formation one expects to find fossil plants of the *Glossopteris* flora in the carbonaceous shales (Plumstead, 1969; MacRae, 1988; Johnson et al., 2006) but not in the coal seams. Coal is the result of alteration of peats (buried plant matter) by high temperatures and pressures after burial and considerable time. The remaining carbon compounds have no recognisable plant material. In contrast, the carbonaceous shales may preserve impressions, or rarely compressions of the plants that grew in the environment. For Gondwanaland these are the *Glossopteris* flora that includes *Glossopteris* leaves, seeds, roots, wood and reproductive structures and other plants such as lycopods, sphenophytes, ferns, cordaitaleans and early gymnosperms (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004; McLoughlin, 2020; Gastaldo et al., 2021a,b).

Quaternary sands may overlie and obscure fossil traps such as palaeo-pans and palaeo-springs but these features are rare in this region. River sands and alluvium might transport fragmentary fossil bones and silicified woods but these would be out of primary context and of minimal scientific value.

iii. Site visit observations

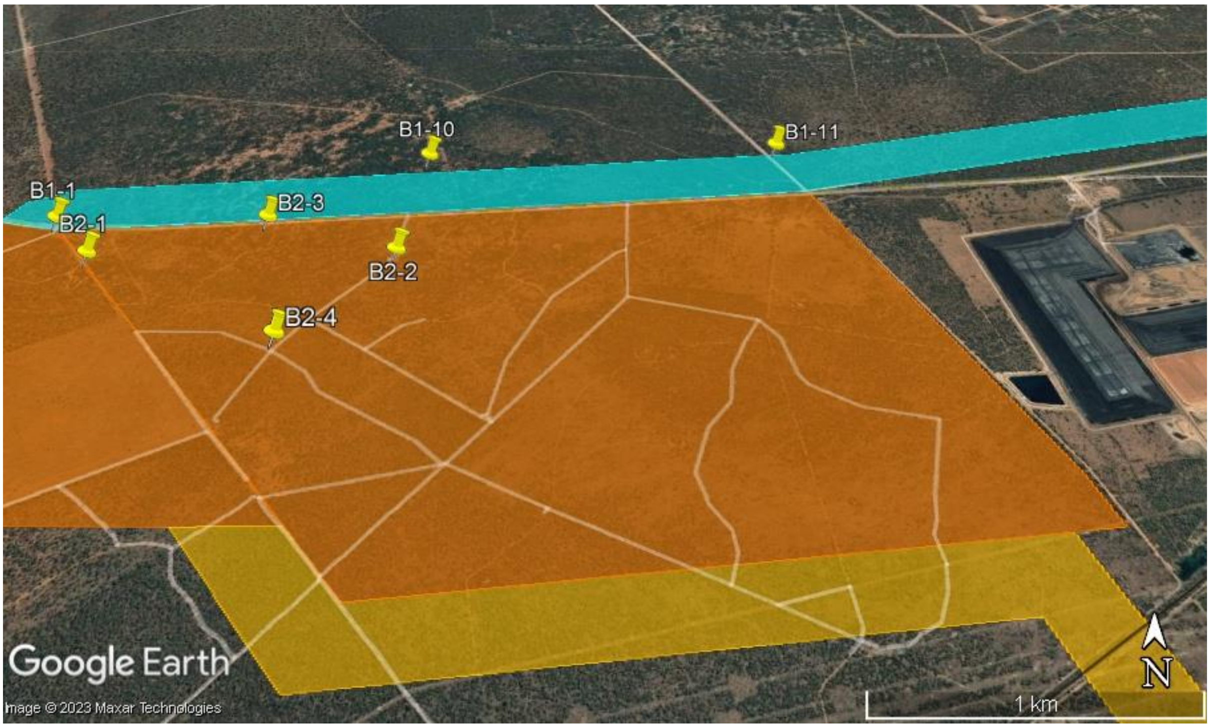

Figure 5: Annotated Google Earth map for the site stops and observations for the Buffalo 2 Solar Park (refer to Table 3).

Table 4: Site observations, GPS points and relevant figures

GPS	Observations	Figures
B2-1 23° 42' 50" S 27° 27' 55" E	North-western corner of the Farm Vergulde Helm 319-IQ, supposed on the Grootegeluk Formation but only sandy soils and bushy woodland, No rocks	6A-D
B2-2 23° 42' 49" S 27° 28' 42" E	North central part with the same sandy soils and vegetation. No rocky outcrops and no fossils.	7A, B
B2-3 23° 42' 42" S 27° 28' 21" E	Same sandy soils and vegetation. No rocky outcrops and no fossils	7C, D
B2-4 23° 43' 06" S 27° 28' 27" E	Same sandy soils and vegetation. No rocky outcrops and no fossils.	8A-D
	Note – the southern part of the project footprint was not surveyed because this is on only moderately	

	fossiliferous Quaternary sands and the same lithology and vegetation were extensively surveyed for the Buffalo 2 Solar Park on the adjacent farm to the west, Buffelsjagt 744-IQ. There were no rocky outcrops and no fossils on that property.	

The vegetation was the same on the arts of the farm surveyed and the topography was completely flat. Only sandy soils were present and no rocks and no rocky outcrops that potentially could preserve fossils were seen. Site photographs are presented in Figures 6-8 and the descriptions are provided in Table 4.

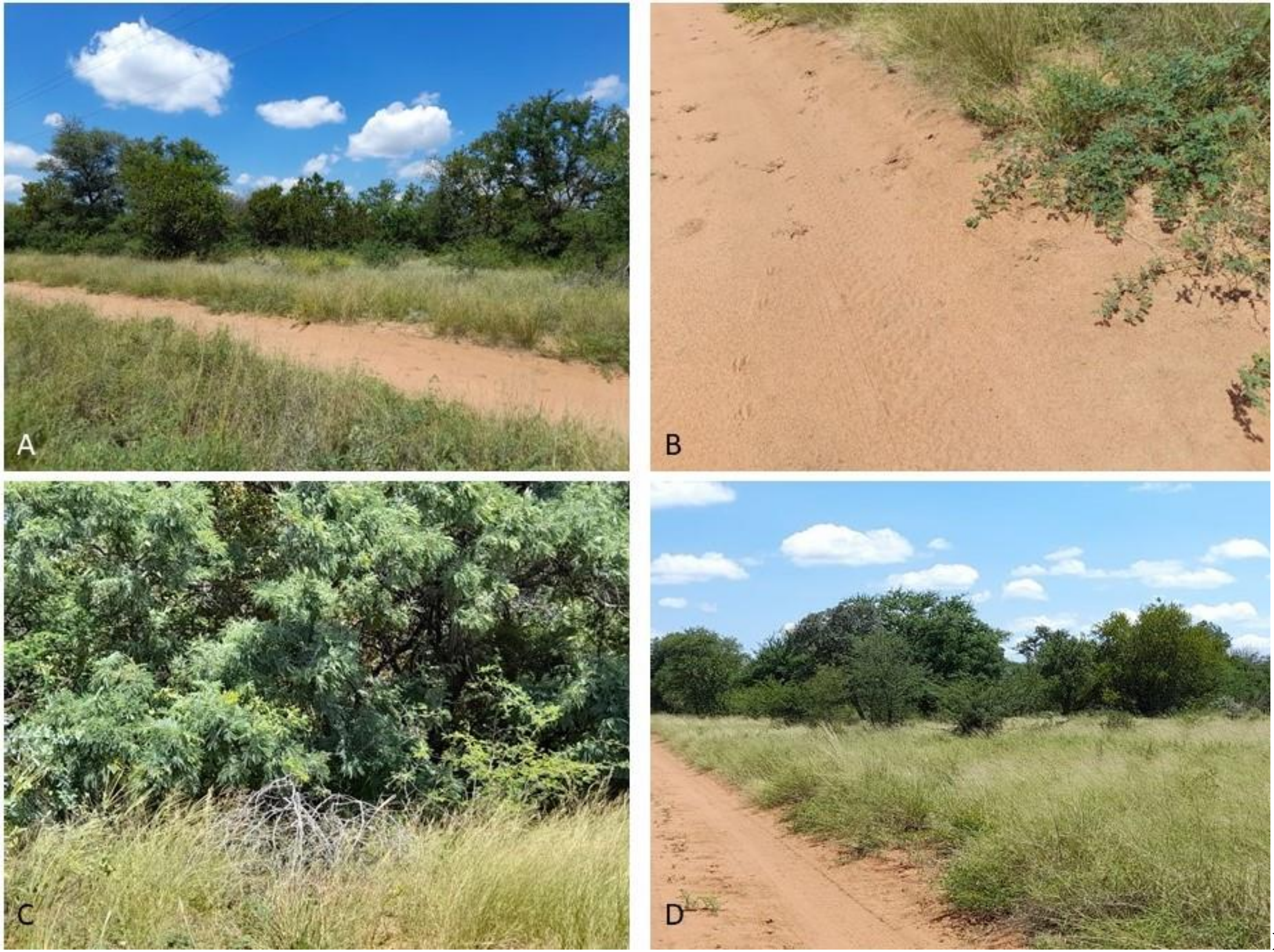

Figure 6.

Figure 7.

Figure 8.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 5.

Table 5: Impact Assessment Criteria

<table>
<tr><th>ASPECT</th><th>IMPACT RATING</th></tr>
<tr><td colspan="2">Status of the impact:
A statement of whether the impact is positive (a benefit), negative (a cost), or neutral Status</td></tr>
<tr><td>Direct impacts</td><td>Impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable</td></tr>
<tr><td>Indirect impacts</td><td>Impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.</td></tr>
<tr><td>Cumulative impacts</td><td>Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.</td></tr>
<tr><td colspan="2">Nature of the impact:
The evaluation of the nature is impact specific. Most negative impacts will remain negative, however, after mitigation, significance should reduce:
• Positive.
• Negative.</td></tr>
<tr><td colspan="2">Extent:
A description of whether the impact would occur on a scale limited to within the study area (local), limited to within 5 km of the study area (area); on a regional scale i.e. Local Municipality (region); or would occur at a national or international scale.
<table><tr><td>Local</td><td>1</td></tr><tr><td>Area</td><td>2</td></tr><tr><td>Region</td><td>3</td></tr><tr><td>National</td><td>4</td></tr><tr><td>International</td><td>5</td></tr></table></td></tr>
<tr><td colspan="2">Duration:
A prediction of whether the duration of the impact would be Immediate and once-off (less than one month), more than once, but short term (less than one year), regular, medium term (1 to 5 years), Long term (6 to 15 years), Project life/permanent (> 15 years, with the impact ceasing after the operational life of the development or should be considered as permanent).
<table><tr><td>Immediate</td><td>1</td></tr></table></td></tr>
</table>

Short term	2
Medium term	3
Long term	4
Project life/permanent	5

Criteria by which impacts are to be assessed

Severity(extent +duration + intensity)

Intensity: This provides an order of magnitude of whether or not the intensity (magnitude/size/frequency) of the impact would be negligible, low, medium, high or very high. This is based on the following aspects:

- an assessment of the reversibility of the impact (permanent loss of resources, or impact is reversible after project life);
- whether or not the aspect is controversial;
- an assessment of the irreplaceability of the resource loss caused by the activity (whether the project will destroy the resources which are easily replaceable, or the project will destroy resources which are irreplaceable and cannot be replaced);
- the level of alteration to the natural systems, processes or systems

Negligible	The impact does not affect physical, biophysical or socio-economic functions and processes.	1
Low/potential harmful	The impact has limited impacts on physical, biophysical or socioeconomic functions and processes.	2
Medium/slightly harmful	The impact has an effect on physical, biophysical and socioeconomic functions and processes, but in such a way that these processes can still continue to function albeit in a modified fashion.	3
High/Harmful	Where the physical, bio-physical and socio-economic functions and processes are impacted on in such a way as to cause them to temporarily or permanently cease.	4
Very high/Disastrous	Where the physical, bio-physical and socio-economic functions and processes are highly impacted on in such a way as to cause them to permanently cease.	5

Incidence (frequency + probability)

Frequency: This provides a description of any repetitive, continuous or time-linked characteristics of the impact: Once Off (occurring any time during construction or operation); Intermittent (occurring from time to time, without specific periodicity); Periodic (occurring at more or less regular intervals); Continuous (without interruption).

Once	Off Once	1
Rare	1/5 to 1/10 years	2
Frequent	Once a year	3
Very frequent	Once a month	4
Continuous	≥ Once a day/ per shift	5

Probability of occurrence: A description of the chance that consequences of that selected level of severity could occur during the exposure.

Highly unlikely	The probability of the impact occurring is highly unlikely due to its design or historic experience.	1
Improbable	The probability of the impact occurring is low due to its design or historic experience.	2
Probable	There is a distinct probability of the impact occurring.	3
Almost certain	It is most likely that the impact will occur.	4
Definite	The impact will occur regardless of any prevention measures.	5

Risk rating

The risk rating is calculated based on input from the above assessments. The incidence of occurrence is calculated by adding the Extent of the impact to the duration of the impact. The Severity of the impact is calculated based on input from the extent of the impact, the duration and the intensity.

Risk = Severity (extent +duration + intensity) x Incidence (frequency + probability)

Significance: The significance of the risk based on the identified impacts has been expressed qualitatively as follows:

- **low** – the impact is of little importance/insignificant, but may/may not require minimal management
- **medium** - the impact is important, management is required to reduce negative impacts to acceptable levels.
- **high** - the impact is of great importance, negative impacts could render development options or the entire project unacceptable if they cannot be reduced to acceptable levels and/or if they are not balanced by significant positive impacts, management of negative impacts is essential.

Low risk	0 – 50
Medium risk	51 – 100
High risk	101 – 150
Low positive	0 – 50
Medium positive	51 – 100
High positive	101 – 150

Table 5b: Impact Rating for the Buffalo 2 Solar Park using the criteria in Table 5a, where mitigation is the removal of fossils from the project footprint.

ASPECT	Rating Pre-mitigation	Rating Post-mitigation
Phase	PLANNING	
Status if impact		
Nature of impact		
Extent		
Duration		
Intensity		
Severity (E + D + Int)		
Frequency		
Probability		
Incidence (F + P)		
Risk (S x I)		
ASPECT	Rating Pre-mitigation	Rating Post-mitigation
Phase	CONSTRUCTION	
Status if impact	Direct	Direct
Nature of impact	Negative	Positive
Extent	1	1
Duration	1	1
Intensity	3	1
Severity (E + D + Int)	1 + 1 + 3 = 5	1 + 1 +1 = 3
Probability	3	1
Frequency	1	1
Incidence (F + P)	1 + 3 = 4	1 + 1 = 2
Risk (S x I)	5 x 4 = 20 = LOW RISK	3 x 2 = 6 = LOW RISK
ASPECT	Rating Pre-mitigation	Rating Post-mitigation
Phase	OPERATION	
Status if impact		
Nature of impact		
Extent		
Duration		
Intensity		
Severity (E + D + Int)		
Probability		
Frequency		
Incidence (F + P)		
Risk (S x I)	None	None
ASPECT	Rating Pre-mitigation	Rating Post-mitigation
Phase	DECOMMISSIONING / REHABILITATION	
Status if impact		
Nature of impact		
Extent		
Duration		
Intensity		
Severity (E + D + Int)		
Probability		
Frequency		
Incidence (F + P)		
Risk (S x I)	None	None

Mitigation
The impact on the palaeontological heritage can be reduced greatly by a palaeontologist conducting a pre-construction site visit to look for fossils and removing any scientifically important fossils with the relevant SAHRA permit.
(See Section 8 and Appendix A).

Positive/Negative Impact
The discovery and removal of fossils as a direct result of this project has a positive impact because prior to this the particular fossils or fossil deposit were unknown to science.

Alternative Routes
As far as the palaeontology is concerned both routes are the same. They only differ in the southwestern section where both routes are on non-fossiliferous dolerite.

Additional Environmental Impacts
As far as the palaeontology is concerned, there are no additional impacts because the fossils are inert and inactive.

Cumulative Impacts
As far as the palaeontology is concerned, there are no cumulative impacts because each site is unique and may or may not have fossils. Fossil bones may be scattered over the landscape but their distribution is erratic and unpredictable. If a bone-bed or plant outcrop occurs this would an aerially small concentration of fossils and very unlikely to extend beyond tens of metres. Therefore, projects on adjacent land parcels are unlikely to add any impact on this project.

No-Go areas
There are no no-go areas because the fossils, if present, can be removed ad curated in a recognised institution such as a museum or university that has the facilities to store and research the fossil material.

Only the **construction phase** could have any impact on the palaeontology because this is when the ground will be excavated and any fossils, if present, would be removed (Appendix A). During the operational and decommissioning phases no new ground will be excavated so there will be no impact.

Summary of impacts

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and type to preserve fossils. The site visit and walk through confirmed that there were NO FOSSILS in the project footprint. Furthermore, the material to be excavated is soil and this does not preserve fossils. Since there is an extremely small chance that fossils from below the ground surface in the Grootegeluk Formation may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to the fossil heritage resources will only occur in the construction phase and is low pre-mitigation and very low post-mitigation. There are no cumulative impacts and no no-go areas.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and some do contain fossil plant, insect, invertebrate and vertebrate material. The site visit verification and walk through on 11 March 2023 by the palaeontologists confirmed that there are NO FOSSILS on the ground surface in the project footprint. The sands of the Quaternary period would not preserve fossils. It is not known what lies below the surface soils and sands.

6. Recommendation

Based on the fossil record but confirmed by the site visit and walk through there are NO FOSSILS of the *Glossopteris* flora even though fossils have been recorded from rocks of a similar age and type in South Africa. It is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur in below the ground surface in the shales of the Grootegeluk Formation so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations and drilling have commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample. This mitigation process must be added to the EMPr.

The impact will only be during the construction phase and pre-mitigation will be low risk and post-mitigation will be low risk. There will be no cumulative impact or risk and there are no no-go areas.

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Abbreviations

AMAFA	Heritage Kwazulu-Natal
BID	Background Information Document
BGIS	Biodiversity GIS
BSP	Biodiversity Sector Plan
CARA	Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)
CBA	Critical Biodiversity Area
DBAR	Draft Basic Assessment Report
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs
DFFE	Department of Fisheries, Forestry and Environment
DMRE	Department of Mineral and Resources and Energy
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIA Regulations	Environmental Impact Assessment Regulations, 2014 (as amended 2017)
EMPR	Environmental Management Programme
ES	Ecological Sensitivity
ESA	Ecological Support Areas

eWULAAS	Electronic Water Use Licence Application and Authorisation System
EZEMVELO	KZN Wildlife
FBAR	Final Basic Assessment Report
GDP	Gross Domestic Product
GNR	Government Notice
GPS	Global Positioning System
HDSA	Historically Disadvantaged South Africans
HSA	Hazardous Substances Act, 1973 (Act No. 15 of 1973)
I&AP's	Interested and Affected Parties
IDP	Integrated Development Plan
MHSA	Mine Health and Safety Act, 1996 (Act No. 29 of 1996)
MP	Mining Permit
MPRDA	Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM:AQA	National Environmental Management: Air Quality Control Act, 2004 (Act No. 39 of 2004)
NEM:BA	National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
NEM:PAA	National Environmental Management: Protected Areas Amendment Act, 2014 (Act No. 21 of 2014)
NEM:WA	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
NFA	National Forest Act, 1998 (Act No. 84 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)
NRTA	National Road Traffic Act, 1996 (Act No. 93 of 1996)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
OHSA	Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)
OHSAS	Occupational Health and Safety Management Systems
PCB's	Polychlorinated Biphenyl
PCO	Pest Control Officer
PES	Present Ecological State
PPE	Personal Protective Equipment
PIA	Palaeontological Impact Assessment
PSM	Palaeontological Sensitivity Map
S1	Site Alternative 1
S2	Site Alternative 2
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
SAMBF	South African Mining and Biodiversity Forum
SANS	South African National Standards
SDS	Safety Data Sheet
SEF	Solar Energy Facility / Photovoltaic Facility
WEF	Wind Energy Facility
WMA	Water Management Area
WUL	Water Use Licence
WULA	Water Use Licence Application

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, fossils of plants, insects, bone or coalified material) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 9). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. Appendix A – Examples of fossils from the Vryheid Formation

Figure 9: Photographs of fossils plants from the Vryheid Formation.

10. Appendix B – Details of specialists

Prof Marion Bamford is a palaeobotanist with a PhD in Palaeontology from the University of the Witwatersrand. She conducts her own research in palaeontology from various sites in Africa, lectures to undergraduate students and supervises post-graduate students. She has been doing palaeontological impact assessments in her spare time for the last 26 years and has been doing fieldwork for more than 35 years.

Curriculum vitae (short) - Marion Bamford PhD
January 2023

Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone	:	+27 11 717 6690
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ;

marionbamford12@gmail.com

ii) **Academic qualifications**
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) **Professional qualifications**
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) **Membership of professional bodies/associations**
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative

ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12 - 20 students per year.

vii) **Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
25 years' experience in PIA site and desktop projects

- Selected from recent projects only – list not complete:
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR

- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage

ix) **Research Output**
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 31; Google Scholar h-index = 39; -i10-index = 116 based on 6568 citations.
Conferences: numerous presentations at local and international conferences.

APPENDIX D – SPECIALIST DECLARATION

Company Name	Marion Bamford Consulting		
Specialist Name	Prof Marion Bamford		
Specialist Qualifications	PhD Palaeontology (Wits, 1990)		
Specialist Affiliations/Registration	FRSSAf, mASSAf, PSSA (Palaeontological Society of southern Africa), SASQUA, IOP, IAWA		
Physical Address	24A Eighth Avenue, Parktown North, 2193		
Postal Address	P O Box 652, WITS		
Postal Code	2050	Cell:	082 555 6937
Telephone	011 717 6690	Fax:	--
Email	Marion.bamford@wits.ac.za ; marionbamford12@gmail.com		

DECLARATION BY THE SPECIALIST

I, __Marion Bamford________________________, declare that –

- I act as the independent specialist in this Standard registration process;
- I have performed the work relating to the specialist assessment and/or route or substation location confirmation in an objective manner;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist input and confirming statement relevant to this request for registration, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the proponent all material information in my possession that reasonably has or may have the potential of influencing compliance with the Standards registration process; and
- all the particulars furnished by me in this form are true and correct.

Signature of the Specialist:

_______ ____

Name of Company:

___Marion Bamford Consulting____

Date:

___17 March 2023____