PALAEONTOLOGICAL IMPACT ASSESSMENT

NAOS SOLAR PV PROJECT ONE

NEAR VILJOENSKROON

IN THE FREE STATE PROVINCE

2022

COMPILED FOR:

ENVIRONAMICS ENVIRONMENTAL

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

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Email: elizebutler002@gmail.com

SIGNATURE:

The Palaeontological heritage impact assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 3 – refer to **Appendix A**	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 5 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 6 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1;10 & 12	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 8 Approach and Methodology	-
(f) details of an assessment of the specifically 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;	Section 1;10 & 11	
(g) An identification of any areas to be avoided, including buffers	Section 1 & 12	
(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 6 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 8.1 – Assumptions and Limitation	-
(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 1 and 12	
(k) Any mitigation measures for inclusion in the EMPr	Section 13	
(l) Any conditions for inclusion in the environmental authorisation	Section 13	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 13	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 & 12	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(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	Section 1 and 12	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Basic Assessment (BA) and Environmental Management Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments regarding heritage/ Palaeontology resources that require input from a specialist

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
		have been raised.
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice 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.	Section 3 compliance with SAHRA guidelines	

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Environamics Environmental Consultants to conduct the **Palaeontological Impact Assessment** (PIA) to assess the proposed Naos Solar PV One Project near Viljoenskroon in the Free State. In accordance with the National Environmental Management Act 107 of 1998 (NEMA) and to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed Naos Solar PV Project One and associated grid connection is underlain by Quaternary sands, the Vryheid Formation (Ecca Group, Karoo Supergroup), Hekpoort, Stubenkop and Daspoort Formations of the Pretoria Group (Transvaal Supergroup). The updated geology also indicates that the Malmani Subgroup of the Chuniespoort Group (Transvaal Supergroup) is present in the development. The Pretoria Group sedimentary rocks in and near the study area are extensively intruded, and locally metamorphosed, by sills of diabase. The diabase has a Zero Palaeontological Sensitivity. However, the existence of the diabase rocks would have had a thermal metamorphic effect on nearby sediments and would decrease the chance of fossil preservation. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Vryheid Formation is Very High, that of the Daspoort Formation is High, while that of the Hekpoort Formation and Quaternary soils are Medium. The Palaeontological sensitivity of the Stubenkop Formation is Low, while that of diabase is Zero (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 13 August 2022. No fossiliferous outcrop was detected in the proposed development. Six grid connection alternatives as well as two collector substation's location alternatives have been proposed for the Naos Solar PV Project One. These alternatives are mainly underlain by the Vryheid Formation, Quaternary sands as well as diabase. As no fossiliferous outcrops were found on the development there is no preference between them from a palaeontological point of view. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is therefore considered that the proposed development will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the

ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO/site manager must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Naos Solar PV Project One Construction Stage **Six Power line Alternatives** Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One Six Power line alternatives Operational Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One Six Power Line Alternatives Decommissioning Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One Construction Stage **2 Substation layout Alternatives** Construction Phase Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact

Naos Solar PV Project One Operational Phase 2 Substation layout Operational Phase	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One 2 Substation layout Decommissioning Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One **Solar Project** Construction Phase	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One Solar Project	No Impact		No Impact		No Impact
Naos Solar PV Project One Solar Project	No Impact		No Impact		No Impact

It is therefore considered that the proposed Naos Solar PV Project One is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. Thus, the construction of the development may be authorised in its whole extent.

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1 INTRODUCTION

The Naos Solar photovoltaic (PV) Cluster is planned near Viljoenskroon in the Free State (**Figure 1**). The proposed Cluster will consist of Naos PV Solar Project One, Naos PV Solar Project Two, and Naos PV Solar Project Three. Environamics Environmental Consultants has been appointed to conduct the Basic Assessment (BA) for the project.

The focus of this report is Naos Solar PV Project One (Figure 2-8)**.**

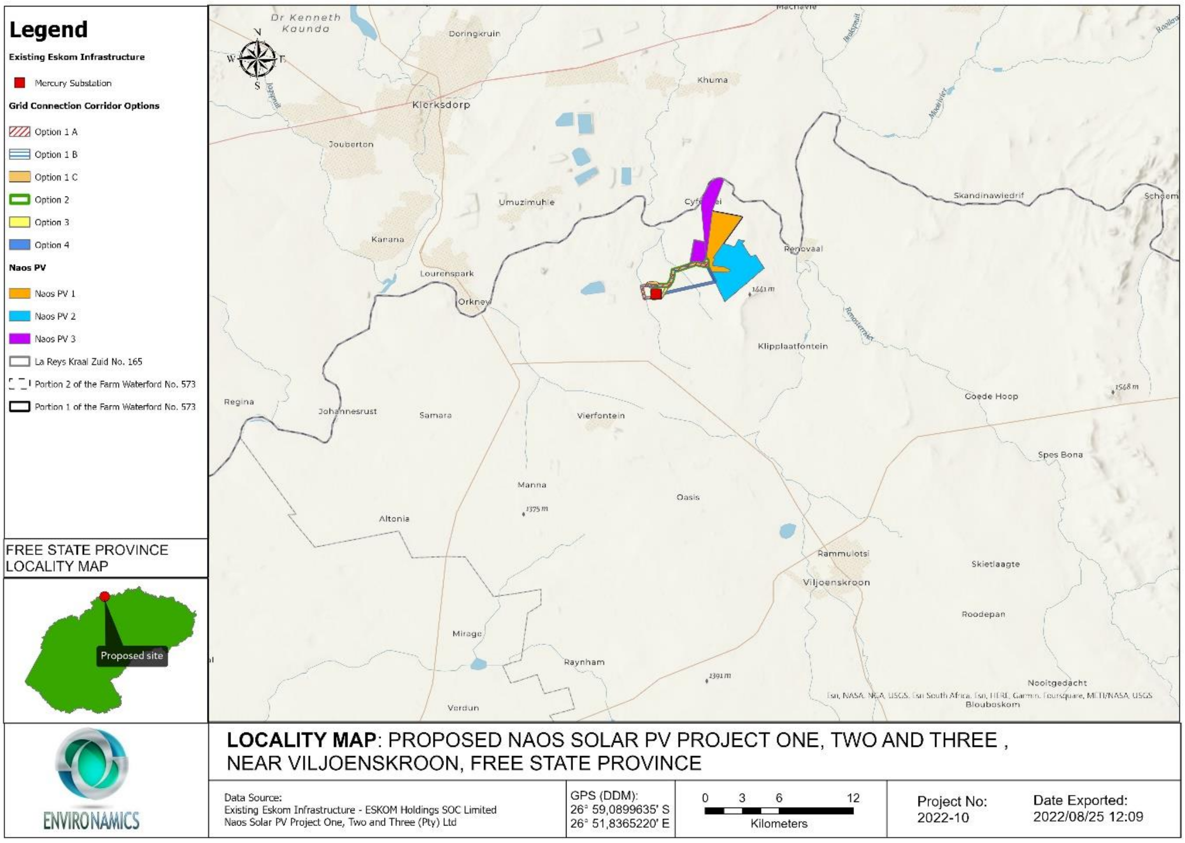

Figure 1:*Regional Locality of the proposed Naos PV Solar Cluster near Viljoenskroon in the Free State.*

Table 2:General site information

Description of affected farm portions	<u>Naos Solar PV Project One</u> Portion 1 of the Farm Waterford No. 573 <u>Power Line Alternatives 1A, 1B and 1C (1B is the technically preferred alternative)</u> Portion 1 of the Farm Waterford No. 573 Portion 1 La Reys Kraal Zuid No. 165 Portion 2 of the Farm Kleinfontein No. 369 Remaining Extent of the Farm Kleinfontein No. 369 Portion 2 of the Farm Zaaiplaats No. 190 Portion 3 of the Farm Zaaiplaats No. 190 Portion 2 of the Farm Biesiefontein No. 173

	Farm Doornplaats 599 <u>Power Line Alternative 2</u> Portion 1 of the Farm Waterford No. 573 Portion 1 La Reys Kraal Zuid No. 165 Portion 2 of the Farm Kleinfontein No. 369 Remaining Extent of the Farm Kleinfontein No. 369 Portion 2 of the Farm Zaaiplaats No. 190 Portion 3 of the Farm Zaaiplaats No. 190 Portion 2 of the Farm Biesiefontein No. 173 <u>Power Line Alternative 3</u> Portion 1 of the Farm Waterford No. 573 Portion 1 La Reys Kraal Zuid No. 165 Portion 1 of the Farm Kleinfontein No. 369 Portion 2 of the Farm Kleinfontein No. 369 Remaining Extent of the Farm Kleinfontein No. 369 Portion 3 of the Farm Zaaiplaats No. 190 Portion 2 of the Farm Biesiefontein No. 173 <u>Power Line Alternative 4</u> Portion 1 of the Farm Waterford No. 573 Portion 2 of the Farm Waterford No. 573 Portion 2 of the Farm Biesiefontein No. 173 Portion 4 of the Farm Biesiefontein No. 173 Remaining Extent of the Farm Biesiefontein No. 173 Portion 1 of the Farm Kleinfontein No. 369 Portion 3 of the Farm Zaaiplaats No. 190
Province	Free State
District Municipality	Fezile Dabi District Municipality
Local Municipality	Moqhaka Local Municipality
Ward numbers	22
Closest towns	The town of Viljoenskroon is located approximately 24 km south of the proposed developments.
21 Digit Surveyor General codes	<u>Naos Solar PV Project One</u> Portion 1 of the Farm Waterford No. 573 - F03600000000057300001 <u>Power Line Alternatives 1A, 1B and 1C (1B is the technically preferred alternative)</u> Portion 1 of the Farm Waterford No. 573 - F03600000000057300001 Portion 1 La Reys Kraal Zuid No. 165 - F03600000000016500001 Portion 2 of the Farm Kleinfontein No. 369 - F03600000000036900002 Remaining Extent of the Farm Kleinfontein No. 369 - F03600000000036900000 Portion 2 of the Farm Zaaiplaats No. 190 - F03600000000019000002

	Portion 3 of the Farm Zaaiplaats No. 190 - F03600000000019000003 Portion 2 of the Farm Biesiefontein No. 173 - F03600000000017300002 Farm Doornplaats 599 - F03600000000059900000 <u>Power Line Alternative 2</u> Portion 1 of the Farm Waterford No. 573 - F03600000000057300001 Portion 1 La Reys Kraal Zuid No. 165 - F03600000000016500001 Portion 2 of the Farm Kleinfontein No. 369 - F03600000000036900002 Remaining Extent of the Farm Kleinfontein No. 369 - F03600000000036900000 Portion 2 of the Farm Zaaiplaats No. 190 - F03600000000019000002 Portion 3 of the Farm Zaaiplaats No. 190 - F03600000000019000003 Portion 2 of the Farm Biesiefontein No. 173 - F03600000000017300002 <u>Power Line Alternative 3</u> Portion 1 of the Farm Waterford No. 573 - F03600000000057300001 Portion 1 La Reys Kraal Zuid No. 165 - F03600000000016500001 Portion 1 of the Farm Kleinfontein No. 369 - F03600000000036900001 Portion 2 of the Farm Kleinfontein No. 369 - F03600000000036900002 Remaining Extent of the Farm Kleinfontein No. 369 - F03600000000036900000 Portion 3 of the Farm Zaaiplaats No. 190 - F03600000000019000003 Portion 2 of the Farm Biesiefontein No. 173 - F03600000000017300002 <u>Power Line Alternative 4</u> Portion 1 of the Farm Waterford No. 573 - F03600000000057300001 Portion 2 of the Farm Waterford No. 573 - F03600000000057300002 Portion 2 of the Farm Biesiefontein No. 173 - F03600000000017300002 Portion 4 of the Farm Biesiefontein No. 173 - F03600000000017300004 Remaining Extent of the Farm Biesiefontein No. 173 - F03600000000017300000 Portion 1 of the Farm Kleinfontein No. 369 - F03600000000036900001 Portion 3 of the Farm Zaaiplaats No. 190 - F03600000000019000003

Type of technology	Photovoltaic solar facility
Structure Height	Panels up to 3m, buildings ~ 4m, power line ~30m, BESS ~2.8m
Surface area to be covered (Development footprint)	Naos Solar PV Project One: 550 ha
Structure orientation	Tracking PV with bi-facial panels. Bi-facial panels with single axis tracking is preferred over fixed-axis or double axis tracking systems and mono-facial panels due to the potential to achieve higher annual energy yields whilst minimising the balance of system (BOS) costs, resulting in the lowest levelized cost of energy (LCOE). The development of the PV facility will take into consideration during the final design phase the use of either mono-facial or bi-facial PV panels as well as tracker vs fixed-tilt mounting structures. Both options are considered feasible for the site.
Generation capacity	Up to 300MW (per facility)

1.2 Technical Details

The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e., semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current). The key components of the proposed projects are described below:

- PV Panel Array - To produce up to 300MW, each proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility.

- Battery Energy Storage System (BESS) – The battery energy storage system will make use of Lithium-ion (Lithium Iron Phosphate / Sodium Sulphur) or Vanadium Redox technology and will have a capacity of up to 4.5GWh. The extent of the system will be ~4.57ha.

- Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.

- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 33kV to 132kV. The normal components and dimensions of a distribution-rated electrical substation will be required. A collector substation with a capacity of 132kV will also be required.

The onsite substation will be required on each site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the new proposed power line from the proposed collector substation to the 400kV Mercury Main Transmission Substation (MTS).

Each facility layout for the three respective projects will include two collector substation alternative locations that must be assessed and the preferred location indicated in the respective specialist reports. The developer has also indicated specific internal power lines to connect the collector substation to the main grid connection corridor which will ultimately evacuate the generated power into the national grid. Should the three developments (i.e. Naos Solar PV Project One, Two and Three) all be developed then there would be an overlap of the internal 132kV power lines that will be shared between the facilities to reduce the extent of linear infrastructure required).

It must be noted that for each respective project Collector Substation Option 1 is put forward as the technically preferred option for the respective project layouts. Refer to Figures 2-3 below.

The capacity of the collector substation for each project will be 132kV and the capacity of the internal power lines will be 132kV.

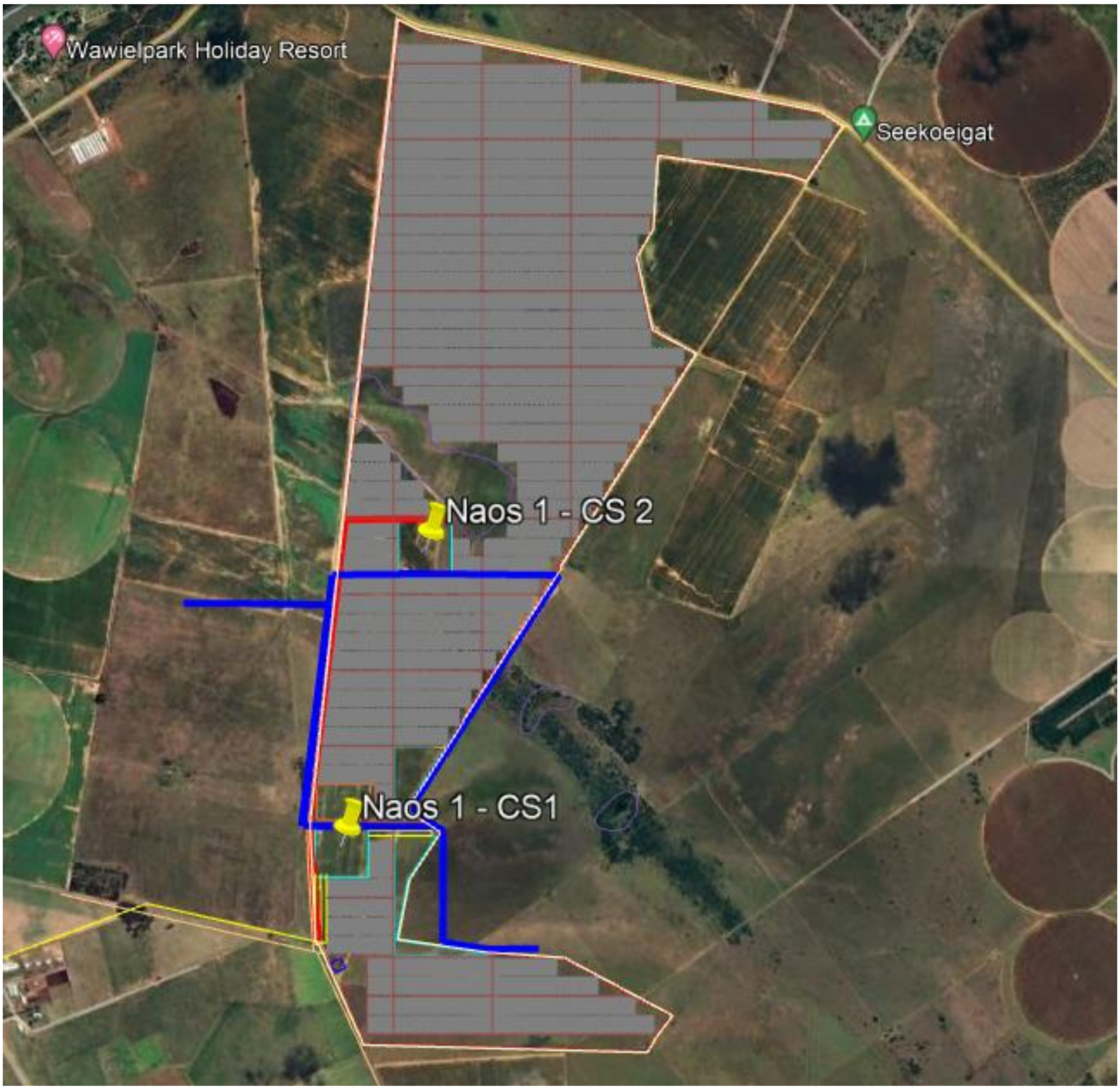

Figure 2: *Internal grid connection solution, with two collector substation alternative locations, for Naos Solar PV Project One (red lines = Naos 1 132kV Eskom power line connecting to the main grid connection corridor for each collector substation alternative, blue lines = Naos 2 & 3 132kV power lines crossing over the Naos Solar PV Project One).*

The power line route to connect each of the respective facilities to the 400kV Mercury Main Transmission Substation will be assessed within a 200m wide grid connection corridor. Six alternative routes are being considered.

Refer to the Figure 3 below.

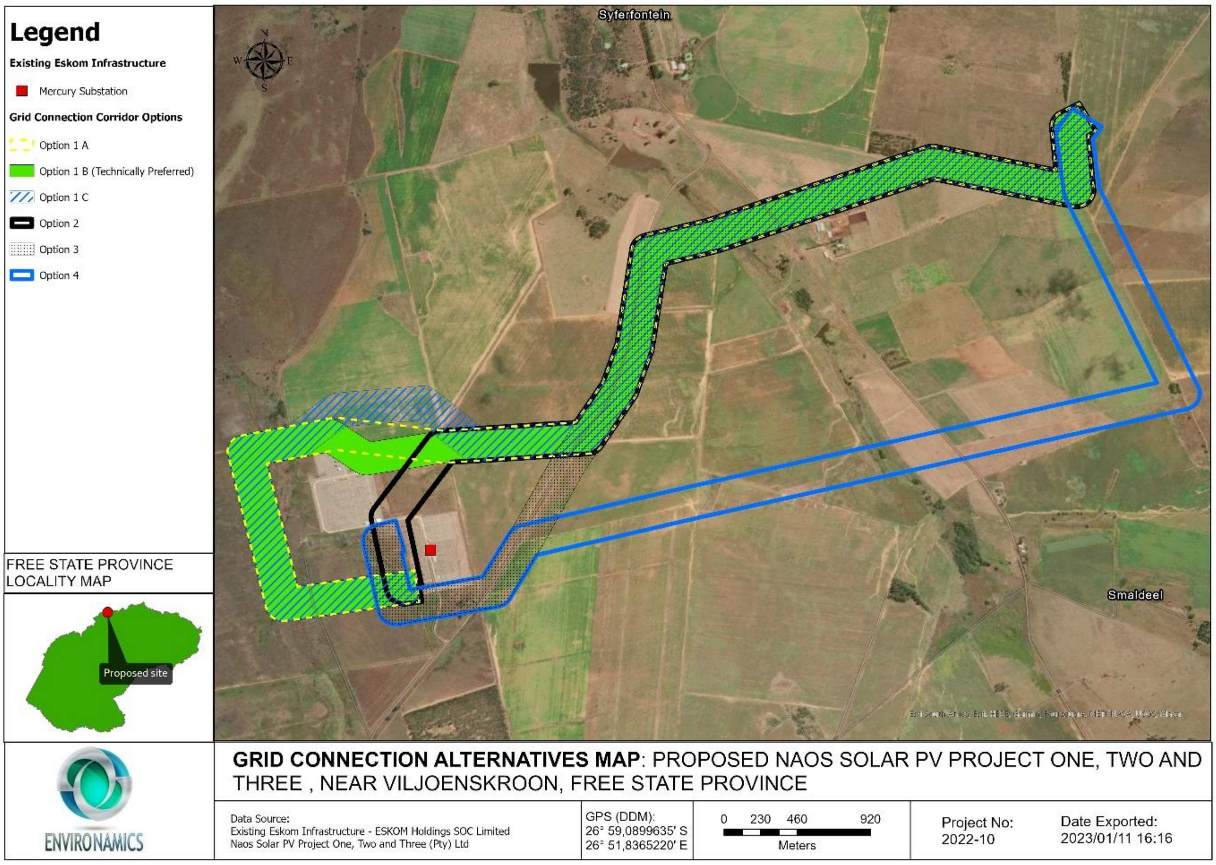

Figure 3: *Six grid connection corridor alternatives proposed for the three Naos PV projects.*

- Supporting Infrastructure – The following auxiliary buildings with basic services including water and electricity will be required on the sites for each project:
  - Operations & Maintenance Building / Office (~2510m²)
  - Switch gear and relay room (~800m²);
  - Staff lockers and changing room (~200m²);
  - Security control (~60m²);
  - Permanent Laydown Area (~~10ha); and
  - Temporary batching plant
- Roads Access will be obtained via the existing Vermaasdrift Road, R59, R501 and S643 roads. Four alternative main access routes are being considered (the preferred route will be determined by the local and / or national roads authorities during the site access permit approval process). An internal site road network will also be required to provide access to each respective solar field and associated infrastructure. Internal access roads will be up to 12m in width. The main access road providing direct access to the project will be up to 8m wide and 6km long.
- Fencing - For health, safety and security reasons, the facilities will be required to be fenced off from the surrounding farms. Each project will have permanent security on site for 24hrs per day, 7 days a week.

Table 3: Technical Details

Component	Description / dimensions
Height of PV panels	Up to 3 meters
Area of PV Array	Naos Solar PV Project One: 550 ha (Development Footprint)
Number of inverters required	Number of String inverters: up to 1500 for Naos 1 Number of Central inverters: up to 90 These are indicative numbers and are subject to change as part of the final facility layout design.
Area occupied by inverter / transformer stations / substations	String inverters (per item): 1 m^2 Central Inverters (per item): 20 m^2 Transformers (per item): 20 m^2 (included in the on-site substation) On-site Facility Substation: up to 2000 m^2 Collector Substation: up to 25000 m^2 BESS: ~4.57ha
Capacity of the on-site substation	33kV / 132kV
Capacity of the collector substation	33kV / 132kV
Capacity of the power line	33kV / 132kV
Area occupied by both permanent and construction laydown areas	Up to 10 ha
Area occupied by buildings	• Operations & Maintenance Building / Office (~2510m² (Naos 1) • Switch gear and relay room (~800m²); • Staff lockers and changing room (~200m²); • Security control (~60m²);
Length of internal roads	up to 24km,
Width of internal roads	up to 12m
Length of internal power lines to connect the collector substations	Naos Solar PV Project One: up to 4km
Grid connection corridor width	200m
Grid connection corridor length	Power Line Alternative 1A – up to 8km Power Line Alternative 1B (technically preferred) – up to 8km Power Line Alternative 1C – up to 8km Power Line Alternative 2 – up to 7km Power Line Alternative 3 – up to 7km Power Line Alternative 4 – up to 7.5km
Power line servitude width	Up to 32m
Height of fencing	Approximately 3 meters

1.3 Consideration of Alternatives

The DEAT 2006 guidelines on 'assessment of alternatives and impacts' proposes the consideration of four types of alternatives namely, the no-go, location, activity, and design alternatives. It is however, important to note that the regulation and guidelines specifically state that only 'feasible' and 'reasonable' alternatives should be explored. It also recognizes that the consideration of alternatives is an iterative process of feedback between the developer and EAP, which in some instances culminates in a single preferred project proposal. An initial site assessment was conducted by the developer of the affected properties and the farm portions were found favourable due to their proximity to grid connections, solar radiation, ecology and relatively flat terrain. These factors were then taken into consideration and avoided as far as possible.

The following alternatives were considered in relation to the proposed activity.

No-go alternative

This alternative considers the option of 'do nothing' and maintaining the status quo. The site is currently zoned for agricultural land uses. Should the proposed activity not proceed, the site will remain unchanged and will continue to be used for agricultural purposes. The potential opportunity costs in terms of alternative land use income through rental for energy facility and the supporting social and economic development in the area would be lost if the status quo persist.

Location alternatives

No other possible sites were identified on the affected property(ies) for the developments. This site is referred to as the preferred site. Some limited sensitive features occur on the site. The size of the site makes provision for the exclusion of any sensitive environmental features that may arise through the BA process to enable the appropriate placement of the infrastructure within the development footprint.

Technical alternatives: Powerlines

Connecting the array to the electrical grid requires transformation of the voltage from 33kV to 132kV. The normal components and dimensions of a distribution-rated electrical substation will be required. A collector substation with a capacity of 132kV will also be required.

The onsite substation will be required on each site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the new proposed power line from the proposed collector substation to the 400kV Mercury Main Transmission Substation (MTS).

Each facility layout for the three respective projects will include two collector substation alternative locations that must be assessed and the preferred location indicated in the respective specialist reports. The developer has also indicated specific internal power lines to connect the collector substation to the main grid connection corridor which will ultimately evacuate the generated power into the national grid. Should the three developments (i.e., Naos Solar PV Project One, Two and Three) all be developed then there would be an overlap of the internal 132kV power lines that will be shared between the facilities to reduce the extent of linear infrastructure required).

It must be noted that for each respective project Collector Substation Option 1 is put forward as the technically preferred option for the respective project layouts. Refer to Figures 4 below.

The capacity of the collector substation for each project will be 132kV and the capacity of the internal power lines will be 132kV.

The lengths of the internal lines per project are as follows:

Naos Solar PV Project One: up to 4km

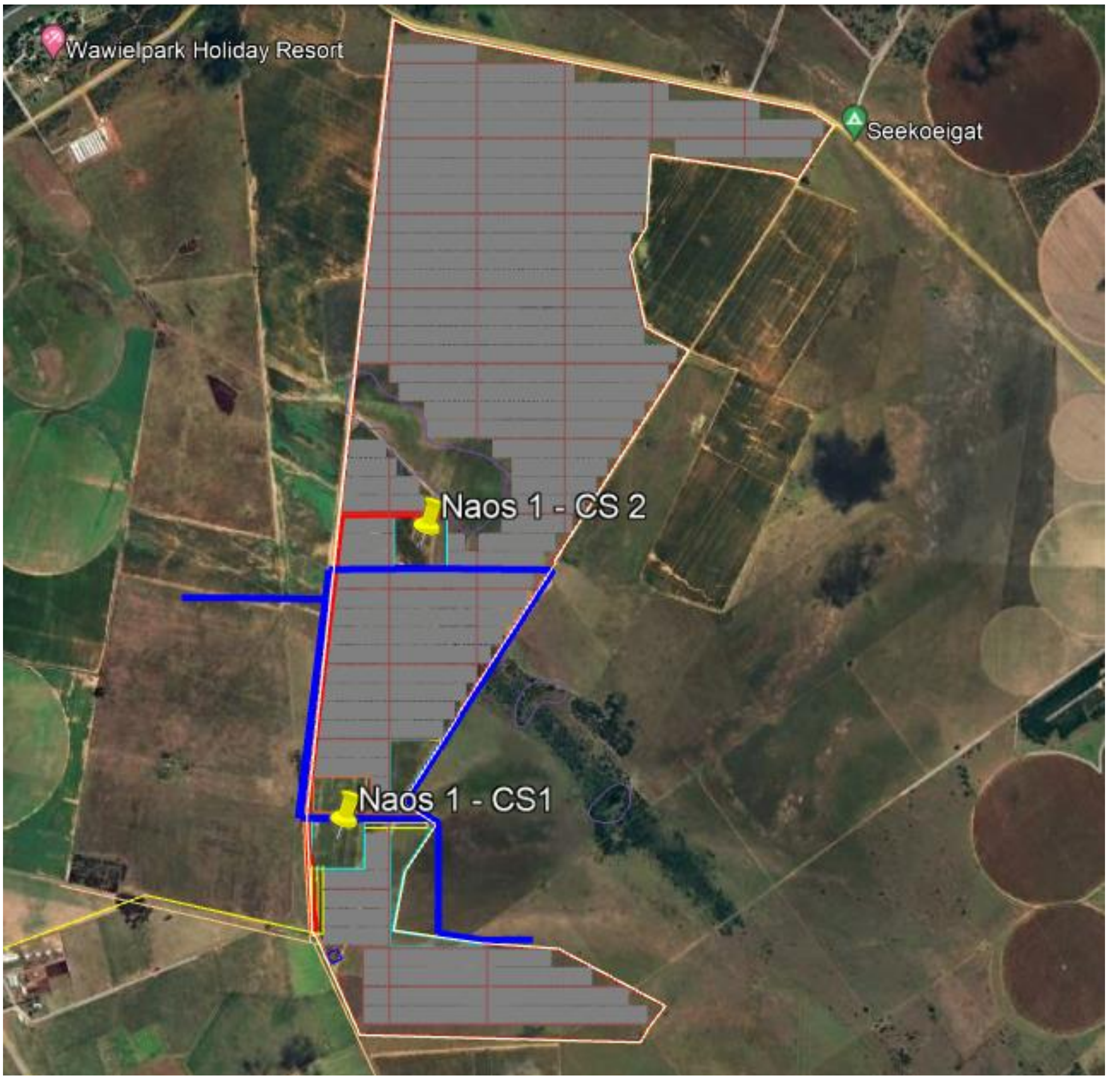

Figure 4: *Internal grid connection solution, with two collector substation alternative locations, for Naos Solar PV Project One (red lines = Naos 1 132kV Eskom power line connecting to the main grid connection corridor for each collector substation alternative, blue lines = Naos 2 & 3 132kV power lines crossing over the Naos Solar PV Project One).*

The power line route to connect each of the respective facilities to the 400kV Mercury Main Transmission Substation will be assessed within a 200m wide grid connection corridor. Six alternative routes are being considered.

Refer to the Figure 5 below.

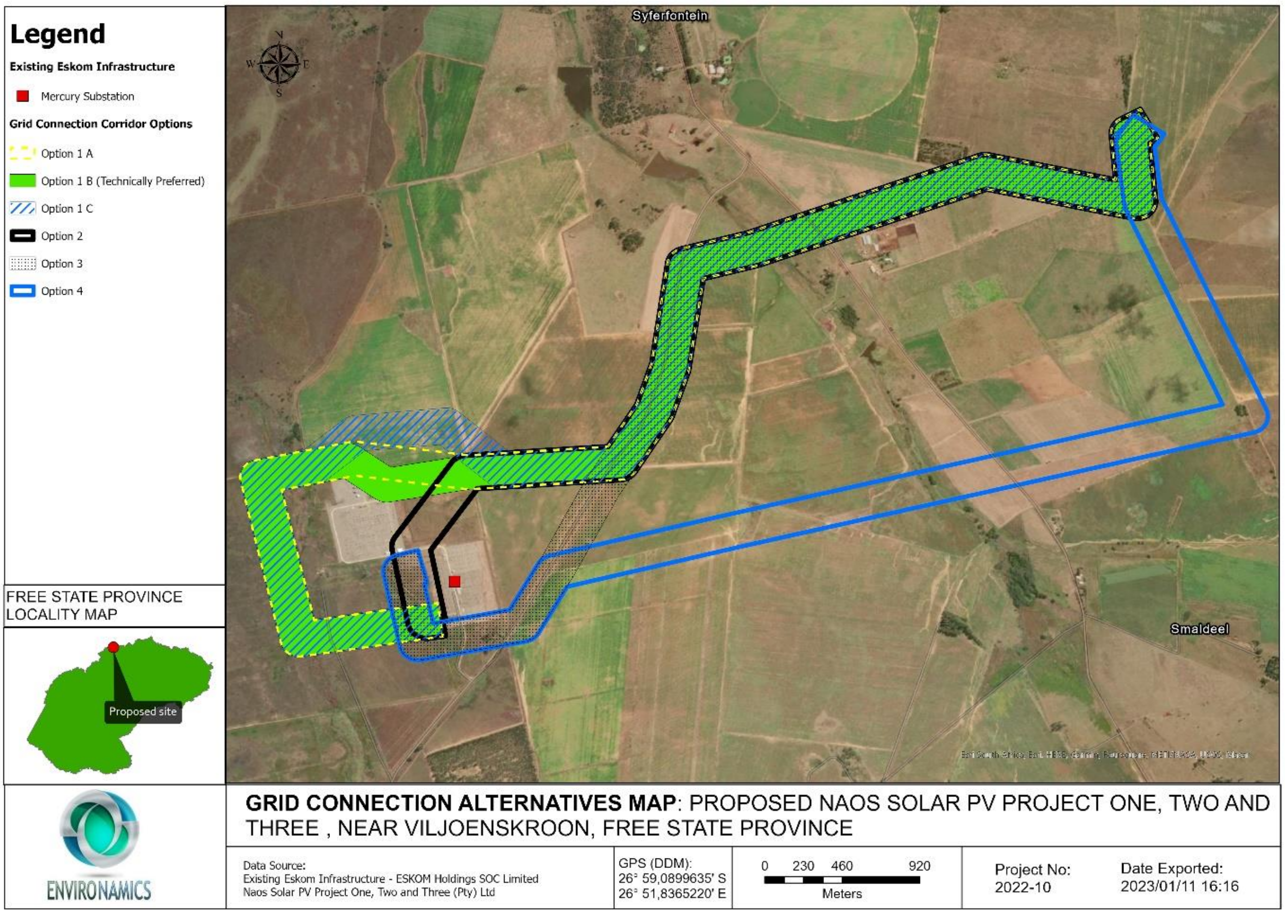

Figure 5: *Six grid connection corridor alternatives proposed for the three Naos PV projects.*

The lengths of the six power line alternatives are as follow:

- Power Line Alternative 1A – up to 8km
- Power Line Alternative 1B (technically preferred) – up to 8km
- Power Line Alternative 1C – up to 8km
- Power Line Alternative 2 – up to 7km
- Power Line Alternative 3 – up to 7km
- Power Line Alternative 4 – up to 7.5km

<u>Technical alternatives: Main Access</u>

In order to gain access to the site four alternative main access routes are being proposed for the development. These include the following:

- Preferred Access Road (Main Road) - 12.6km
- Alternative 1 – 25.6km
- Alternative 2 – 27.5km
- Alternative 3 – 14.6km

The Preferred Access Road (Main Road) follows the S643, where it then crosses over the Vaal River via the Vermaasdrift Bridge and provides direct access to the projects via an existing gravel farm road.

Upgrading of sections of the road to accommodate the construction traffic will be undertaken where required. This route is considered to be the shortest route to the site from the R502 regional road and is therefore considered to be the ideal route for the delivery of equipment.

Alternative 1 provides access to the sites from the south via the R76 regional road, which connects to a gravel farm road which further leads to the existing Vermaasdrift Road. This road is ideal for the delivery of equipment and specifically the transformers. Upgrading of sections of the road to accommodate the construction traffic will be undertaken where required.

Alternative 2 provides access to the sites from the south via the R76 regional road, which connects to a gravel farm road which provides direct access to the sites. This road is ideal for the delivery of equipment and specifically the transformers. Upgrading of sections of the road to accommodate the construction traffic will be undertaken where required.

Alternative 3 provides access to the sites from the west via the R76 regional road, which connects to a gravel farm road which crosses over the existing Vermaasdrift Road and provides direct access to the sites. This road is ideal for the delivery of equipment and specifically transformers. Upgrading of sections of the road to accommodate the construction traffic will be undertaken where required, and a section of new road of about 5km long and 8m wide will need to be undertaken.

The preferred alternatives are the use of the Main Road and Alternative 2 collectively for the projects as these two options provide the most technically sensible solution for the transportation of goods and services to and from the sites. It is therefore requested that the Main Road and Alternative 2 both be authorised for the developments.

Refer to the Figure below.

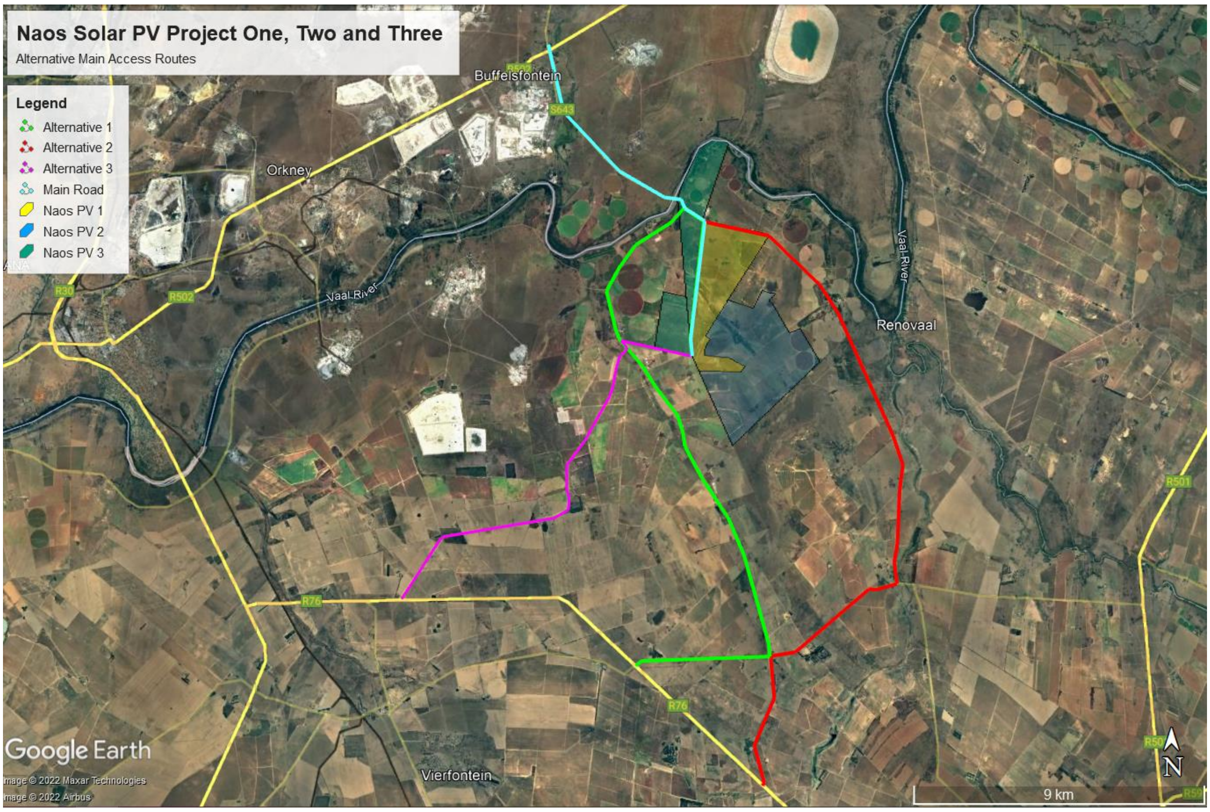

Figure 6: *Main access route alternatives proposed for the three Naos PV projects.*

<u>Design and layout alternatives</u>

Design alternatives will be considered throughout the planning and design phase and specialist studies are expected to inform the final layout of the proposed development.

<u>Technology alternatives</u>

There are several types of semiconductor technologies currently available and in use for PV solar panels. Two, however, have become the most widely adopted, namely crystalline silicon (Mono-facial and Bi-facial) and thin film. The technology that (at this stage) proves more feasible and reasonable with respect to the proposed solar facility is crystalline silicon panels, due to it being non-reflective, more efficient, and with higher durability. However, due to the rapid technological advances being made in the field of solar technology the exact type of technology to be used, such as bifacial panels, will only be confirmed at the onset of the project.

In terms of the type of panel to be installed, the panels will either be fixed tilt or tracking (single axis / dual axis).

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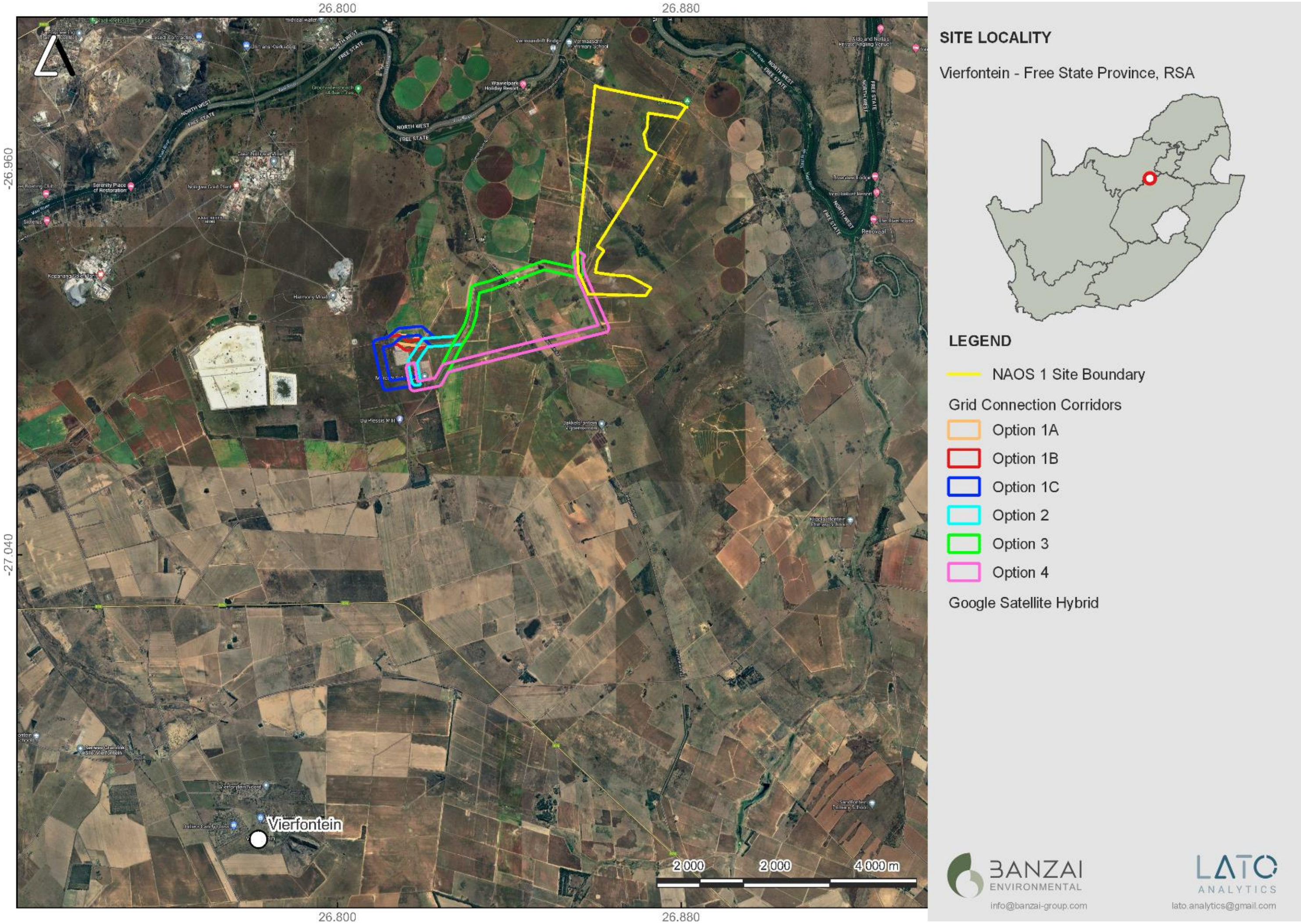

***Figure 7**: Regional locality of the proposed Naos Solar PV One Project near Viljoenskroon in the Free Sate.*

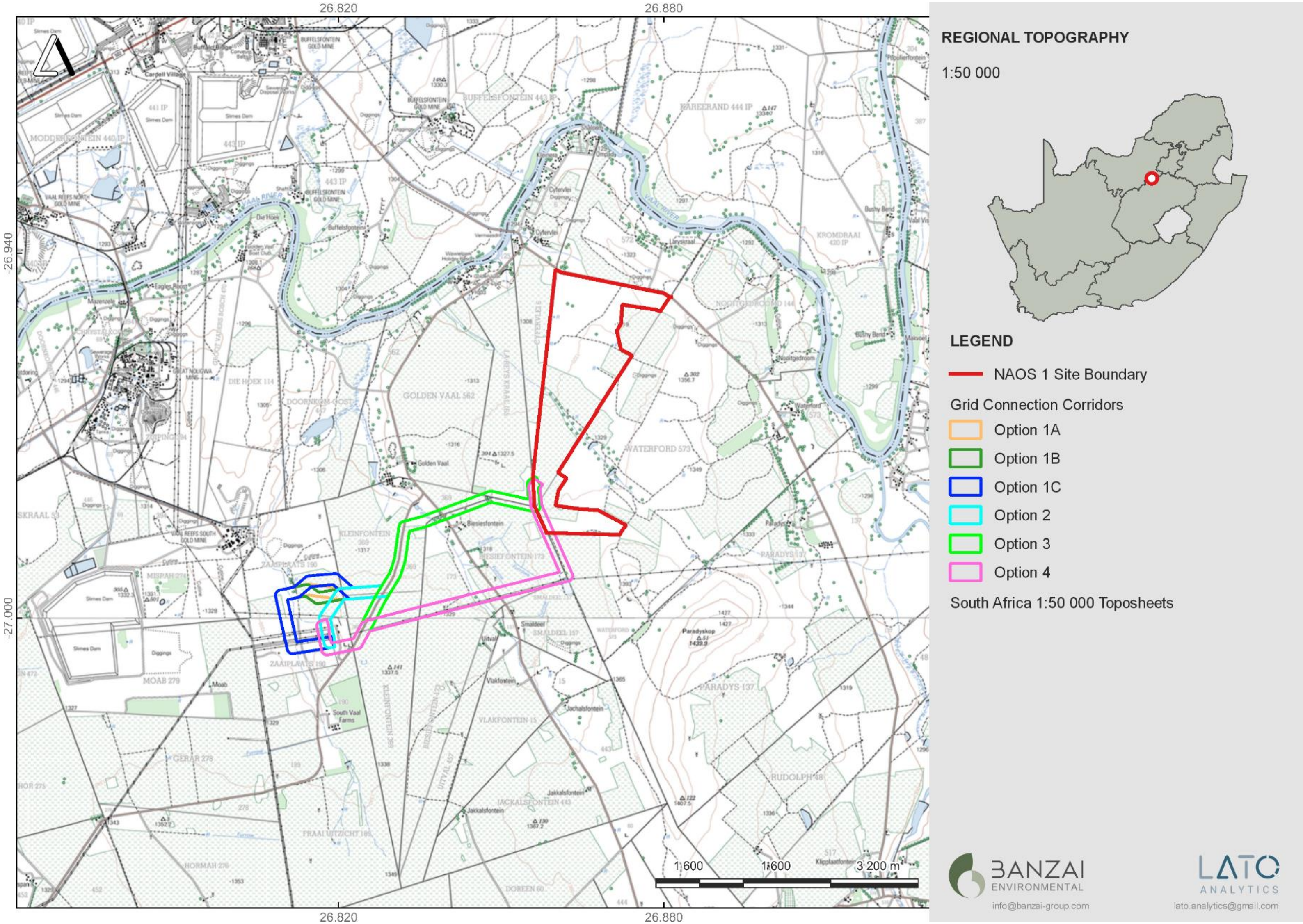

Figure 8: *Regional topography of the proposed Naos Solar PV One Project near Viljoenskroon in the Free Sate.*

2 LEGAL MANDATE AND PURPOSE OF THE REPORT

The National Environmental Management Act identifies listed activities (in terms of Section 24) which are likely to have an impact on the environment. These activities cannot commence without obtaining an EA from the relevant competent authority. Sufficient information is required by the competent authority to make an informed decision and the project is therefore subject to an environmental assessment process which can be either a Basic Assessment Process or a full Scoping and Environmental Impact Assessment process.
The EIA Regulations No. 324, 325, and 327 outline the activities that may be triggered and therefore require EA.

The activities triggered under Listing Notice 1 & 2 (Regulation 327 & 325) for the project implies that the development is considered as potentially having an impact on the environment and therefore require the implementation of appropriate mitigation measures. The project is located in the Klerksdorp Solar Renewable Energy Development Zone. Therefore, the project is subject to a Basic Assessment process, as well as the 57-day timeframe for the processing of the Application for Environmental Authorisation by the Department of Forestry, Fisheries and the Environment (DFFE).

3 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-eight years. She has experience in locating, collecting, and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

4 LEGISLATION

National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **“all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**”.
The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50
- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

The NEMA (No 107 of 1998) states that an integrated EMP should (23:2 (b)) "…*identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*".

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies a comprehensive and legally compatible PIA report has been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or

- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m² in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

5 OBJECTIVE

The objective of a Palaeontological Impact Assessment (PIA) is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area.
- Identification of sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.

c. **Cumulative impacts** are 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.

- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

6 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Naos Solar PV One Project near Viljoenskroon in the Free Sate is depicted on the 1: 250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria (**Figure 9, Table 4-6**).

According to these geological maps the Naos Solar PV Project One is underlain by Quaternary soils (Qs, yellow) and the Vryheid Formation (khaki, Pv Ecca Group, Karoo Supergroup), while the northern portion is underlain by the Hekpoort (Vh, dark green); Stubenkop (Vs, striated grey-brown) and Daspoort (Vd, purple with black dots) Formations of the Pretoria Group (Transvaal Supergroup). The Pretoria Group sedimentary rocks in and near the study area are extensively intruded, and locally metamorphosed, by sills of diabase (di, green in **Figure 9**). The diabase has no palaeontological significance. However, the existence of the diabase rocks would have had a thermal metamorphic effect on the nearby sediments and would decrease the chance of fossil preservation.

According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Quaternary soils and Hekpoort Formations are medium while the Vryheid Formation has a Very high Palaeontological Sensitivity, that of the Daspoort Formation is high while the Stubenkop Formation has a Low Sensitivity. The diabase has a Zero Sensitivity (**Figure 10, Table 7**).

The geology has recently been updated (Council of Geosciences, Pretoria) and indicates that the proposed Naos PV One Project is underlain by the following sediments (**Figure 11**) Vryheid Formation (Ecca Group) and the Hekpoort, Boshoek and Daspoort Formations (Pretoria Group) as well as the Malmani Subgroup (Chuniespoort Group). The most eastern portion of the development is underlain by intrusive diabase rocks that has no Palaeontological Significance. The grid connection is underlain by Vryheid Formation, diabase as well as the Malmani Subgroup.

The Quaternary superficial deposits are the youngest geological deposits formed during the most recent period of geological time (approximately 2.6 million years ago to present). Most of the superficial deposits are unconsolidated sediments and consist of gravel, sand, silt, and clay, and they form relatively thin, often discontinuous patches of sediments.

The Quaternary deposits are of most importance due to the palaeoclimatic changes that are reflected in the different geological formations (Hunter et al., 2006). During the climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa where formed (Maud, 2012). Barnosky (2005) indicated that various warming and cooling events occurred in the Cenozoic but states that climatic changes during the Quaternary Period, specifically the last 1.8 Ma, were the most drastic climate changes relative to all climate variations in the past. Climate variations that occurred in the Quaternary Period were both drier and wetter than the present and resulted in changes in river flow patterns, sedimentation processes and vegetation variation (Tooth et al., 2004).

Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil deposits. These fossil assemblages resemble modern animals and may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

The Vryheid Formation is known to contain a rich assemblage of Glossopteris flora (spathulate, reticulate-veined leaves) which is the source vegetation for the Vryheid Formation. Gymnospermous glossopterids (**Figure 12**) dominated the peat and non-peat accumulating of Permian wetlands after continental deglaciation took place (Falcon, 1986c, Greb *et al*., 2006). Recent palaeobotanical studies include that of Adendorff (2005), Bordy and Prevec (2008) and Prevec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) has described numerous plant fossils from this formation (e.g., *Azaniodendron fertile*, *Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Hirsutum* sp., *Scutum* sp., *Ottokaria* sp., *Estcourtia* sp., *Arberia* sp., *Lidgetonnia* sp., *Noeggerathiopsis* sp., *Podocarpidites* sp_) as well as more than 20 Glossopteris species. In the past, palynological studies have focused on the coal-bearing successions of the Vryheid Formation and include articles by Aitken (1993, 1994, 1998), and Millsteed (1994, 1999), while recent studies were conducted by Götz and Ruckwied, (2014).

To date no fossil vertebrates have been collected from the Vryheid formation. The occurrence of fossil insects is rare, while palynomorphs are diverse. Non-marine bivalves and fish scales have also been reported from this formation. Trace fossils are abundantly found but the diversity is low.

The mesosaurid reptile, *Mesosaurus* (**Figure 13**) has been found in the southern parts of the basin but may also be present in other areas of the Vryheid formation. Although fossils are rare in this biozone, a single fossil may be of scientific important as many fossil taxa are known from only a single fossil.

The Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton of South Africa namely the Griqualand West Basin, Transvaal Basin, as well as the Kanye Basin in Botswana. The Griqualand West Basin can be subdivided into the Ghaap Plateau and Prieska sub basins. The geometry of the three basins is mostly stratiform with the exclusion of the volcanic precursor of the Kanye Basin and parts of the Griqualand West Basin. Extensive deformation has taken place in the south-western portion of the Griqualand West Basin. Rocks of the Transvaal Supergroup in the Transvaal Basin were intruded by the Bushveld Complex approximately 2060 million years ago. The Transvaal Supergroup overlays the Archaean basement as well as the Witwatersrand and Ventersdorp Supergroups. In the far western and Kanye Basins rocks belonging to the Kanye Formation and Gaborone Granite Suite is also overlain by the Transvaal Supergroup.

The Precambrian Transvaal Supergroup is approximately 2550-2050 Ma years old (Bekker et al. 2008; Catuneanu et al 1999), (Late Archaean to Early Proterozoic) and is about 15 km thick. This Supergroup consists of sedimentary, volcanic and unmetamorphosed clastic rocks. The sandstone dominated Magaliesberg Formation overlies the mudrocks of the Silverton Formation, and in turn the Silverton Formation overlies the sandstone dominated Daspoort Formation.

The Daspoort Formation overlies the Strubenkop (Eriksson et al., 1993b). The Daspoort Formation is characterised by subordinate mudrocks and ironstones in the east of the basin (Button, 1973a), and mature quartz arenites. Erikson et al (1993b) also describes pebbly arenites, immature sandstones, conglomerates and mudrocks in this formation that reflects the beginning of a major marine transgression that deposited the Silverton and Magaliesberg Formations (Eriksson et al., 1995). Thin stromatolitic cherts and carbonates (top of formation) normally changes into a condensed, transgressive dolomite or chert and is finally covered by the Silverton Shales. The Silverton Formation is a lithologically varied, mudrock-dominated sequence that was deposited on an offshore shelf along the borders of the Kaapvaal Craton (Eriksson et al. 2002, 2009). Volcanic ash-rich intervals are common as well as minor beds of carbonate and chert. Sandstones become more regular in the upper part of the sequence and was deposited under shallower conditions. In the eastern part of the Pretoria Basin, the Machadodorp Member lies in the middle of the Silverton Formation and is represented by a conspicuous interval of volcanic rocks (including agglomerates basaltic lavas as well as tuffs). The presence of the volcanic pillow lavas and water-lain tuffs indicates that they were formed beneath the sea. The deep-water Silverton mudrocks were deposited in high sea levels and was followed by shallowing fluvial and deltaic sandstones in low sea levels of the overlying Magaliesberg Formation. The Hekpoort formation consists of Basaltic andesite and pyroclastic rocks and is volcanic in origin. In the south the basaltic andesitic lavas are more than 1100m thick thinning to 800m in the west and is less than 50m thinning in the north. Sub-aerial fissure eruptions are dominant, with local pyroclastic systems (Oberholzer, 1995). Small lacustrine shale deposits are present between recurrent hiatuses in volcanism. Button (1973a) suggested an uppermost, widespread palaeosol.

The Malmani Subgroup carbonates of the Transvaal Basin comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes (Eriksson *et al.* 2006). Stromatolites are layered mounds, columns and sheet-like sedimentary rocks (Figure 6). These structures were originally formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. These algae photosynthesised in the low oxygen atmosphere and deposited layer upon layer of calcium sulphate, magnesium sulphate and calcium carbonate as well as other compounds to form these domes. Researchers have examined and classified the stromatolite structures but seldomly find preserved algal cells. The oxygen atmosphere that we depend on today was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

Stromatolites and oolites from the Transvaal Supergroup have been described by various authors (Eriksson and Altermann, 1998). Detailed descriptions of South African Archaean stromatolites are available in the literature (Altermann, 2001; Buick, 2001; and Schopf, 2006). The Malmani stromatolites literature includes articles by Truswell and Eriksson (1972, 1973, 1975), Eriksson and MacGregor (1981), Eriksson and Altermann (1998), Sumner (2000), Schopf (2006).

Currently very few palaeontologists study stromatolites but geologists find the stromatolites interesting because they reveal the change from a reducing environment (that is an oxygen-poor) to an oxidizing environment (oxygen--rich). This transition is known as the Great Oxygen Event (Eroglu et al., 2017).

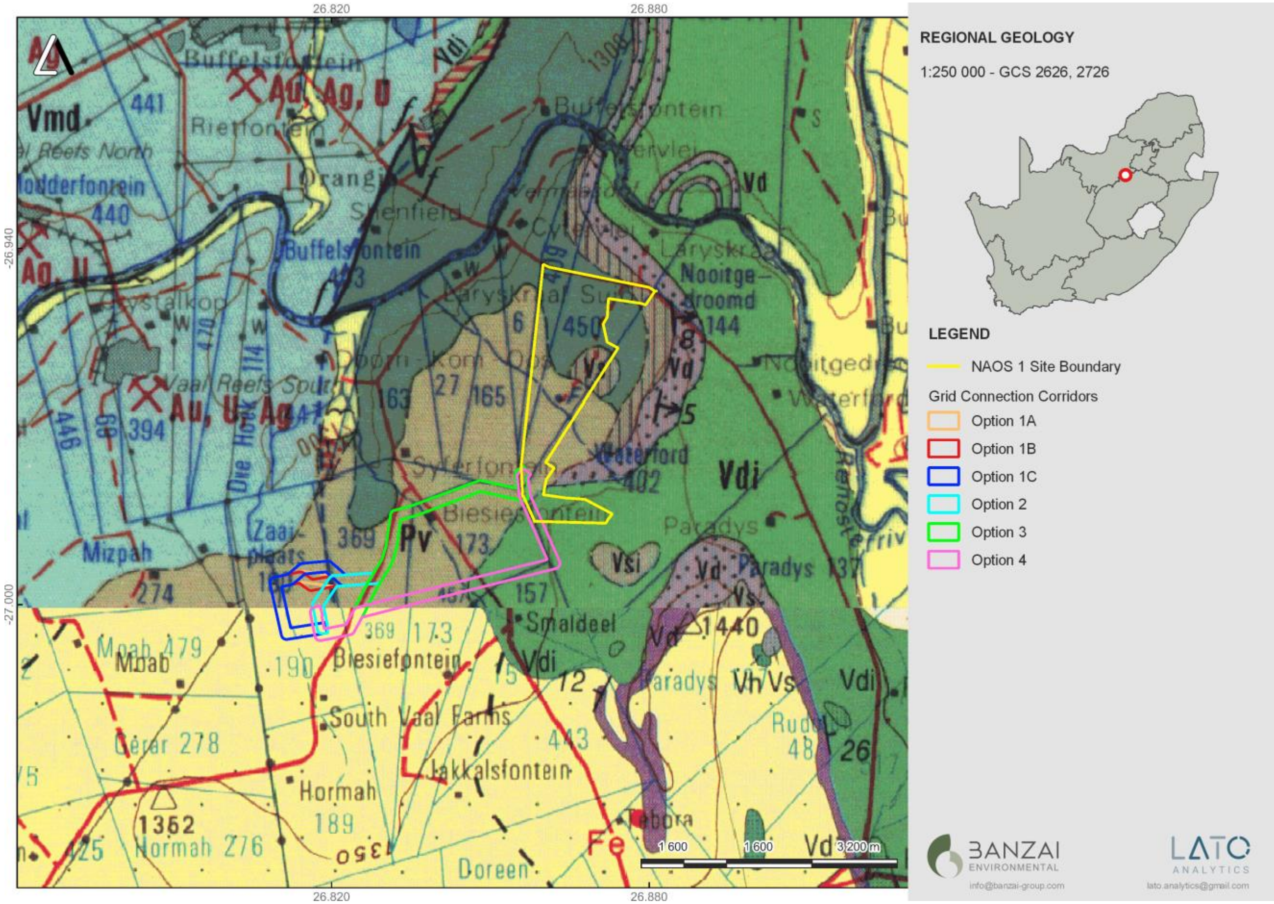

Figure 9: Extract of the 1:250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria) indicating the proposed Naos Solar PV One Project near Viljoenskroon in the Free Sate.

The proposed Naos Solar PV One and the grid connection alternatives are underlain by Quaternary soils, Vryheid Formation (Ecca Group, Karoo Supergroup) as well as the Stubenkop and Hekpoort Formations (Pretoria Group, Transvaal Supergroup) and unfossiliferous diabase.

Table 4:Legend of the 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria)

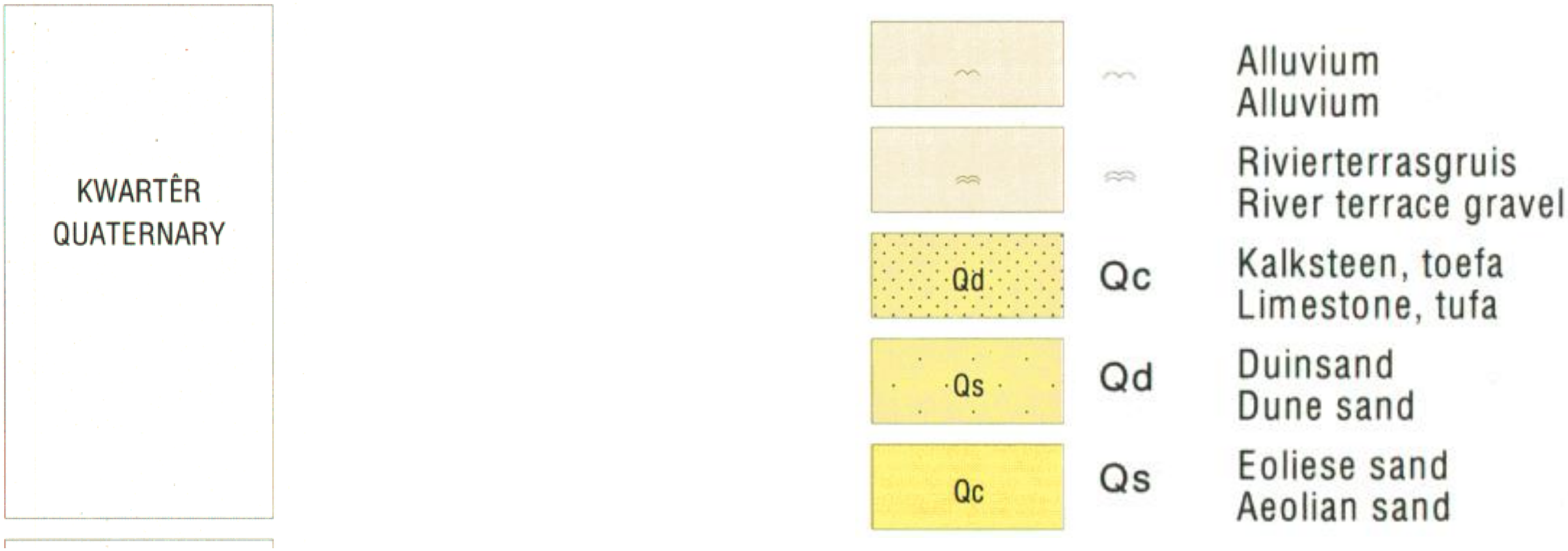

Table 5:Legend of the Wes-Rand 2626 (1986) Geological Map (Council for Geosciences, Pretoria)

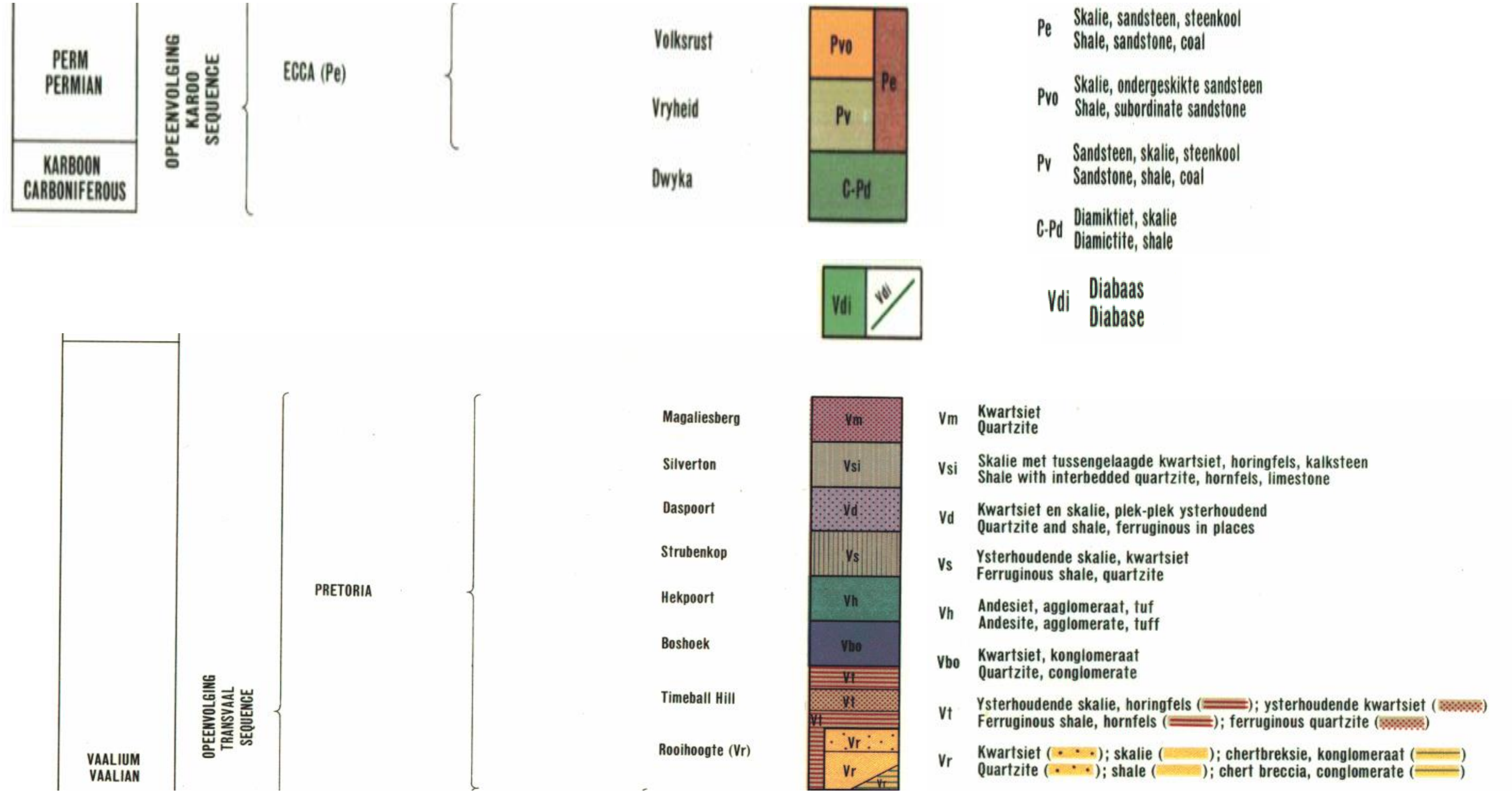

Table 6:Legend of the Wes-Rand 2626 (1986) Geological Map (Council for Geosciences, Pretoria

Group	Subgroup	Formation	Symbol	Description
CHUNIESPOORT	Malmani (Vmd)		Vmd	Dolomiet, chert en oorblyfsels van chertbreksie van die Formasie Rooihoogte Dolomite, chert and remnants of chert breccia of the Rooihoogte Formation
		Eccles (Ve)	Ve	Chertryke dolomiet, chert en oorblyfsels van chertbreksie van die Formasie Rooihoogte ( ) Chert-rich dolomite, chert and remnants of chert breccia of the Rooihoogte Formation ( )
		Lyttelton (Vl)	Vl	Donker chertarm dolomiet Dark chert-poor dolomite
		Monte Christo (Vmm)	Vmm	Chertryke dolomiet—tussengelaagde gestreepte chert ( ); tussengelaagde oölitiese chert ( ) Chert-rich dolomite—interbedded banded chert ( ); interbedded oolitic chert ( )
		Oaktree (Vo)	Vo	Donker chertarm dolomiet Dark chert-poor dolomite
		Swartrif Black Reef	Vbr	Kwartsiet, konglomeraat, skalie Quartzite, conglomerate, shale

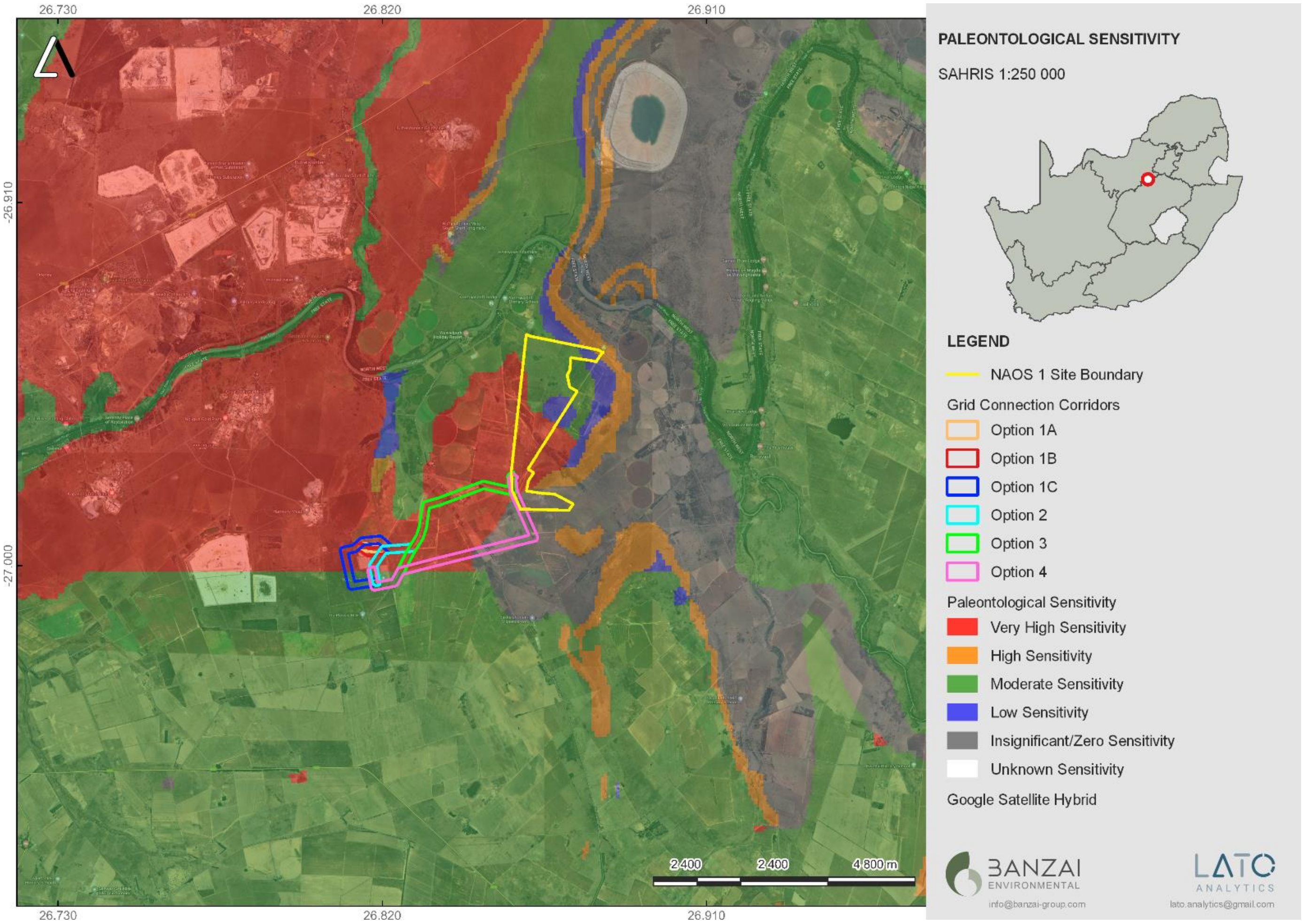

Figure 10: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the Naos Solar PV One Project and grid connection alternatives near Viljoenskroon in the Free State.

Table 7:Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website

Colour	Sensitivity	Required Action
RED	**VERY HIGH**	**Field assessment and protocol for finds is required**
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	**MODERATE**	**Desktop study is required**

BLUE	LOW	No palaeontological studies are required however a protocol for finds is required
GREY	**INSIGNIFICANT/ZERO**	**No palaeontological studies are required**
WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

According to the SAHRIS Palaeosensitivity map (**Figure 10**) the proposed development is underlain by sediments with a Very High (red), High (orange), Moderate (green), Low (blue) and Zero (grey) Palaeontological Sensitivity.

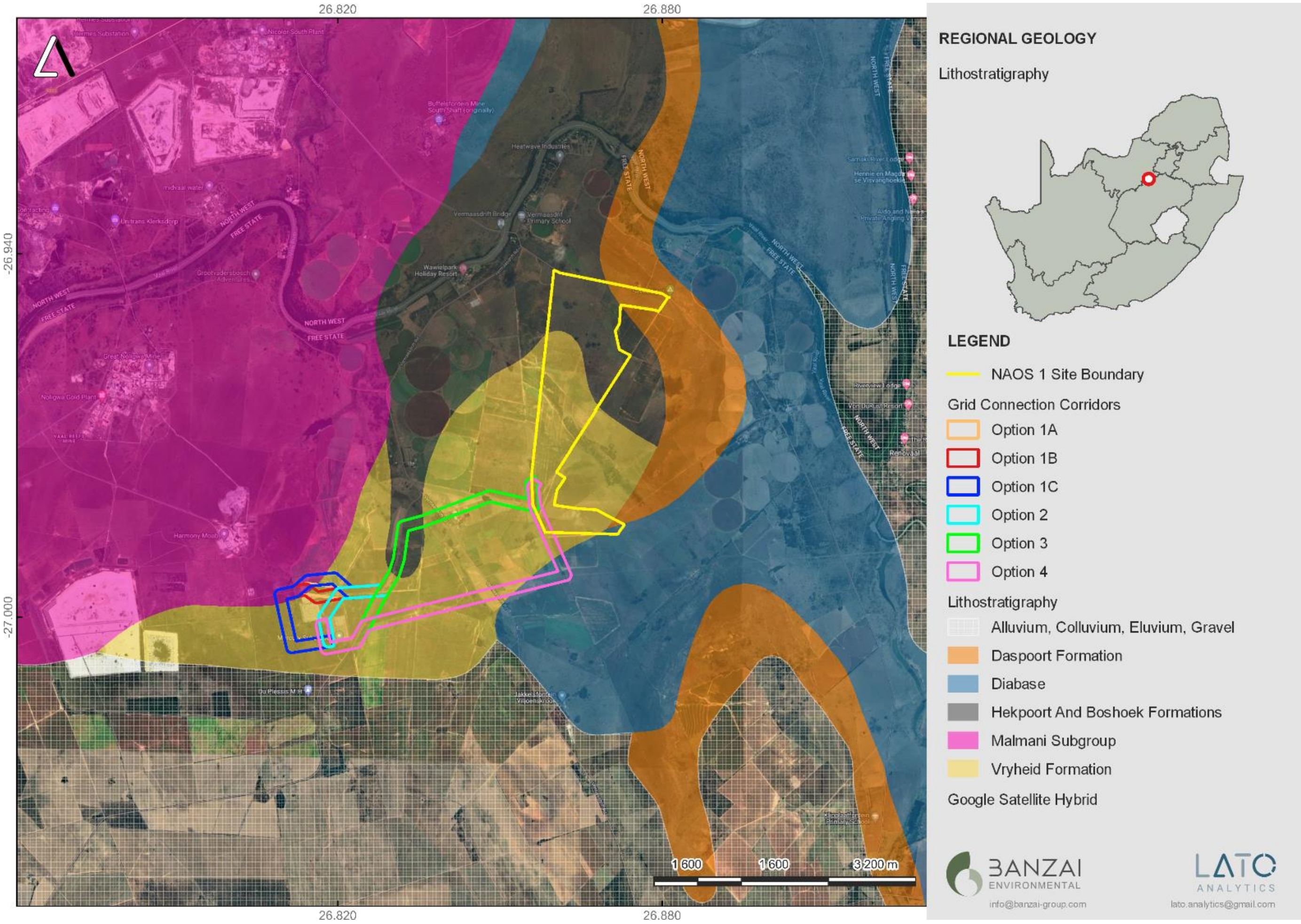

Figure 11:*Updated Geology (Council of Geosciences, Pretoria) of the proposed Naos Solar PV One Project and grid connection near Viljoenskroon in the Free Sate.*

This map indicates that the PV development is underlain by Quaternary sands, the Vryheid Formation (Ecca Group) as well as the Hekpoort, Boshoek, Daspoort Formations (Pretoria Group) as well as the Malmani Subgroup (Chuniespoort Group), while diabase is present in the east.

Figure 12:*Examples of Glossopteris leaves (Prevec et al 2009).*

Figure 13: *Mesosaurus sp. National Museum specimen NMQR3536*

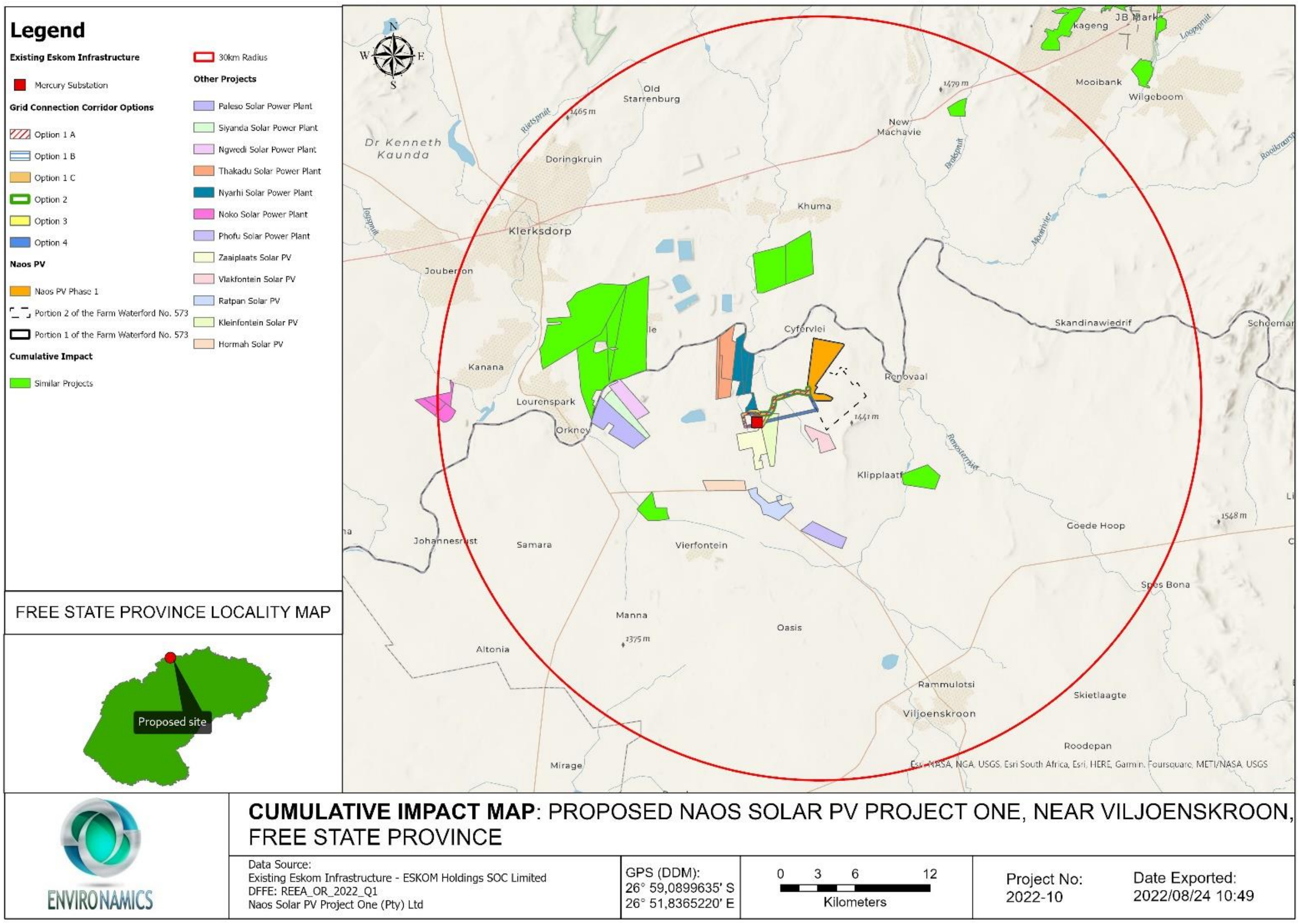

***Figure 14**: Cumulative Impact Map indicating the similar Solar Power plants and grid connections in a 30 km radius of Naos Solar PV Project One.*

Solar Facilities in a 30km radius of Naos Solar PV One Project will have a Zero to High Palaeontological Sensitivity. However, it is important to note that the quality of preservation of these different sites will most probably vary and it is thus difficult to allocate a Cumulative Sensitivity to the projects. If all the mitigation measures are carried out, a conservative estimate of the Cumulative impacts on fossil Heritage will vary between Low and Medium.

Table 8:A summary of related facilities, that may have a cumulative impact, in a 30 km radius of the solar energy facility.

Site name	Distance from study area	Proposed generating capacity	DEFF reference	EIA process	Project status
Paleso SPP[1]	11km	150MW	14/12/16/3/3/1/2365	Basic Assessment	Approved
Siyanda SPP	10km	150MW	14/12/16/3/3/1/2369	Basic Assessment	Approved
Thakadu SPP	4km	150MW	14/1216/3/3/1/2476	Basic Assessment	Approved
Ngwedi SPP	9km	150MW	14/12/16/3/3/1/2535	Basic Assessment	In process
Nyarhi SPP	3km	150MW	14/12/16/3/3/1/2533	Basic Assessment	In process
Kabi Vaalkop PV 3	13km	75 MW	12/12/20/2513/3	Scoping and EIA	Approved
Kabi Vaalkop PV 2	12km	75 MW	12/12/20/2513/2	Scoping and EIA	Approved
Kabi Vaalkop PV[2]	11km	75 MW	12/12/20/2513/4	Scoping and EIA	Approved
Kabi Vaalkop PV 1	11km	75 MW	12/12/20/2513/1	Scoping and EIA	Approved
Buffels Solar PV 1	8km	100MW	14/12/16/3/3/2/777	Scoping and EIA	Approved
Buffels Solar PV 2	8km	100 MW	14/12/16/3/3/2/778	Amendment	Approved
Rietvlei solar	16 km	-	14/12/16/3/3/2/450	Scoping and EIA	Withdrawn/Lapsed
Genesis Orkney Solar (Pty) Ltd	24 km	100MW	14/12/16/3/3/2/954	Scoping and EIA	Approved

[1] Environamics was the EAP responsible for the Basic Assessments for the Paleso, Siyanda, Ngwedi, Nyarhi and Thakadu Solar Power Plants.
[2] The application was only for transmission infrastructure (i.e. substation and power lines) and not a PV solar power plant.

Afropulse 538 Pty Ltd	7 km	50MW	12/12/20/2280	BAR	Withdrawn/Lapsed
Mulilo Renewable Project Developments (Pty) Ltd (Cluster Development): Vlakfontein Solar PV1 (Pty) Ltd Biesiefontein Solar PV1 (Pty) Ltd Kleinfontein Solar PV1 (Pty) Ltd Zaaiplaats Solar PV1 (Pty) Ltd Hormah Solar PV1 (Pty) Ltd Ratpan Solar PV1 (Pty) Ltd Ratpan Solar PV2 (Pty) Ltd	2.78	75 – 100MW	Projects only in commencement phase with no Applications for EA submitted as yet	BAR	In process (commencement Phase)

It is unclear whether other projects not related to renewable energy is or has been constructed in this area, and whether other projects are proposed. In general, development activity in the area is focused on agriculture and mining. It is quite possible that future solar farm development may take place within the general area.

7 GEOGRAPHICAL LOCATION OF THE SITE

The prosed Naos Solar PV Project One is located on Portion 1 of the Farm Waterford No. 573 near Viljoenskroon in the Free State Province (**Figure 2-4**).

Power Line Alternatives 1A, 1B and 1C (1B is the technically preferred alternative)

Portion 1 of the Farm Waterford No. 573

Portion 1 La Reys Kraal Zuid No. 165

Portion 2 of the Farm Kleinfontein No. 369

Remaining Extent of the Farm Kleinfontein No. 369

Portion 2 of the Farm Zaaiplaats No. 190

Portion 3 of the Farm Zaaiplaats No. 190

Portion 2 of the Farm Biesiefontein No. 173

Farm Doornplaats 599

<u>Power Line Alternative 2</u>

Portion 1 of the Farm Waterford No. 573

Portion 1 La Reys Kraal Zuid No. 165

Portion 2 of the Farm Kleinfontein No. 369

Remaining Extent of the Farm Kleinfontein No. 369

Portion 2 of the Farm Zaaiplaats No. 190

Portion 3 of the Farm Zaaiplaats No. 190

Portion 2 of the Farm Biesiefontein No. 173

<u>Power Line Alternative 3</u>

Portion 1 of the Farm Waterford No. 573

Portion 1 La Reys Kraal Zuid No. 165

Portion 1 of the Farm Kleinfontein No. 369

Portion 2 of the Farm Kleinfontein No. 369

Remaining Extent of the Farm Kleinfontein No. 369

Portion 3 of the Farm Zaaiplaats No. 190

Portion 2 of the Farm Biesiefontein No. 173

<u>Power Line Alternative 4</u>

Portion 1 of the Farm Waterford No. 573

Portion 2 of the Farm Waterford No. 573

Portion 2 of the Farm Biesiefontein No. 173

Portion 4 of the Farm Biesiefontein No. 173

Remaining Extent of the Farm Biesiefontein No. 173

Portion 1 of the Farm Kleinfontein No. 369

Portion 3 of the Farm Zaaiplaats No. 190

8 METHODS

The aim of a desktop study is to evaluate the possible risk to palaeontological heritage in the proposed development. This includes all trace fossils as well as all fossils in the proposed footprint. All possible information is consulted to compile a desktop study, and this includes the following: all Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical as well as geological maps.

8.1 Assumptions and Limitations

The focal point of geological maps is the geology of the area and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. Locality and geological information of museums and university databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is also used to provide information on the existence of fossils in an area which has not been documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally **assumed** that exposed fossil heritage is present within the footprint. A field-assessment will thus improve the accuracy of the desktop assessment.

9 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from Environamics.
- 1:250 000 Wes-Rand 2626 (1986) and 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria)
- Palaeontological Impact Assessments in the area of the development (see references)

10 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 13 August 2022. No fossiliferous outcrops were identified during the site visit. The development has a flat topography and is used for agriculture.

***Figure 15**:The study area is covered by thick grassy vegetation and Quaternary sands with no surface outcrops visible.*

11 IMPACT ASSESSMENT METHODOLOGY

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e., site, local, national or global whereas intensity is defined by the severity of the impact e.g., the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 4.1.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

11.1 Impact Rating System

Impact assessment must take account of the nature, scale and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the project phases:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

Table 9:The rating system

NATURE		
Loss of fossil heritage.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).

2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still

		continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.

4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity. The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.

51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

Table 10:Summary of Impacts

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

Environmental parameter	**Issues**	**Rating prior to mitigation**	**Average**	**Rating post mitigation**	**Average**
Naos Solar PV Project One Construction Stage **Six Power line Alternatives** Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One Six Power line alternatives Operational Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One Six Power Line Alternatives Decommissioning Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One Construction Stage **2 Substation layout Alternatives** Construction Phase	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact

Loss of fossil heritage					
Naos Solar PV Project One Operational Phase 2 Substation layout Operational Phase	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One 2 Substation layout Decommissioning Phase	No Impact		No Impact		No Impact
Naos Solar PV Project One **Solar Project** Construction Phase	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	48	Negative Medium impact	16	Negative Low impact
Naos Solar PV Project One Solar Project	No Impact		No Impact		No Impact
Naos Solar PV Project One Solar Project	No Impact		No Impact		No Impact

12 FINDINGS AND RECOMMENDATIONS

The proposed Naos Solar PV Project One and associated grid connection is underlain by Quaternary sands, the Vryheid Formation (Ecca Group, Karoo Supergroup), Hekpoort, Stubenkop and Daspoort Formations of the

Pretoria Group (Transvaal Supergroup). The updated geology also indicates that the Malmani Subgroup of the Chuniespoort Group (Transvaal Supergroup) is present in the development. The Pretoria Group sedimentary rocks in and near the study area are extensively intruded, and locally metamorphosed, by sills of diabase. The diabase has a Zero Palaeontological Sensitivity. However, the existence of the diabase rocks would have had a thermal metamorphic effect on nearby sediments and would decrease the chance of fossil preservation. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Vryheid Formation is Very High, that of the Daspoort Formation is High, while that of the Hekpoort Formation and Quaternary soils are Medium. The Palaeontological sensitivity of the Stubenkop Formation is Low, while that of diabase is Zero (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 13 August 2022. No fossiliferous outcrop was detected in the proposed development. Six grid connection alternatives as well as two collector substation's location alternatives have been proposed for the Naos Solar PV Project One. These alternatives are mainly underlain by the Vryheid Formation, Quaternary sands as well as diabase. As no fossiliferous outcrops were found on the development there is no preference between them from a palaeontological point of view. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is therefore considered that the proposed development will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO/site manager must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.

13 CHANCE FINDS PROTOCOL

The following procedure will only be followed if fossils are uncovered during the excavation phase of the development.

13.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act No 25 of 1999) (NHRA).** According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and is the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

13.2 Background

A fossil is the naturally preserved remains (or traces thereof) of plants or animals embedded in rock. These organisms lived millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

13.3 Introduction

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

13.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information

to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from the environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix A

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	30 years in Palaeontology
EDUCATION:	B.Sc Botany and Zoology, 1988 University of the Orange Free State B. Sc (Hons) Zoology, 1991 University of the Orange Free State Management Course, 1991 University of the Orange Free State M. Sc. *Cum laude* (Zoology), 2009 University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA)	2006-currently

EMPLOYMENT HISTORY

Part time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

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