PALAEONTOLOGICAL FIELD ASSESSMENT FOR THE MOEDING SOLAR PV FACILITY AND ASSOCIATED GRID CONNECTION, NORTH WEST PROVINCE

Savannah Ref No.:SE2141

Prepared for:

Savannah Environmental (Pty) Ltd

PO Box 148

Sunninghill

Johannesburg

2157

December 2018

Prepared by

BANZAI ENVIRONMENTAL (PTY) LTD

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 favourable 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 favourable 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 realise that a false declaration is an offence 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

Tel: +27 844478759

Email: elizebutler002@gmail.com

SIGNATURE: 

The Palaeontological Field Assessment report has been compiled considering the NEMA Appendix 6 requirements for specialist reports as indicated in the table below.

Section in EIA Regulations 2014 (as amended)		**Clause**	**Section in Report**
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Page ii of the report, Contact details and company
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Section 2, Appendix 1
	(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 4
	(cA)	An indication of the quality and age of base data used for the specialist report;	N/A
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 11
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Section 7
	(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 5
	(g)	An indication of any areas to be avoided,	N/A

		including buffers;	
	(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 5
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1
	(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Section 9
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 13
	(l)	Any conditions for inclusion in the environmental authorization;	N/A
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	N/A
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Section 13
		(iA) regarding the acceptability of the proposed activity or activities; and	Section 13
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 13
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable.
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable.
	(q)	Any other information requested by the authority.	Not applicable
	(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.	Not applicable

EXECUTIVE SUMMARY

Moeding Solar (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake the Basic Assessment (BA) process for the Moeding Solar PV Facility, as well as the associated grid connection. The proposed project development is located south of Vryburg in the North West Province within the Vryburg Renewable Energy Development Zone (REDZ) 6 and within the Northern Transmission Corridor. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a Palaeontological Impact Assessment is key to detect the presence of fossil material within the proposed development footprint and study area and it is thus essential to evaluate the impact of the construction and operation of the development site on the palaeontological resources.

The Moeding Solar Facility's grid connection is situated in the northern part of the project development area and is underlain by the Vryburg Formation of the Transvaal Supergroup while the rest of the development (Solar PV facility) is primarily underlain by the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup. The Schmidtsdrift Subgroup has a High Palaeontological sensitivity while the Vryburg Formation has a moderate Palaeontological Sensitivity.

A site visit was undertaken on the 30th of June 2018. The site visit (PV facility and grid alternatives) revealed that the project site near Vryburg consists of characteristic flat-lying terrain and vegetation cover of grassy thornveld. Poorly- to fairly well-preserved, stromatolite assemblages (loose as well as *in situ*) were recorded within the proposed project site. Mapping of the stromatolites identified within the project site was very difficult due to the vegetation and gravelly soil. It is suggested that the overall impact of the proposed Moeding Solar PV facility and associated grid connection is of **negative medium significance** in palaeontological heritage terms.

The two power line alternatives (1 and 2) for the grid connection is entirely underlain by the Vryburg Formation of the Transvaal Supergroup. During the site visit no fossils were recovered from the proposed grid sites and thus **no preferences on the grounds of palaeontological fossil heritage for any specific grid layout under consideration was identified. However, fossil assemblages were detected in the project site and thus mitigation is suggested.** Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the proposed development footprint by a palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme for the Moeding Solar PV Facility project.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Loss of fossil heritage (PV Facility)	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-48	Negative medium impact	-7	Negative low impact
Cumulative impact	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-56	Negative medium impact	-7	Negative low impact
Impact associated grid connection alternative 1	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-16	Negative low impact	-7	Negative low impact
Impact associated grid connection Grid Alternative 2	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-16	Negative low impact	-7	Negative low Impact

The construction and operation of the Moeding Solar PV Facility Power Project (also applicable to the two alternative powerlines) is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area **once** mitigation recommendations have been fully complied with.

CONTENTS

LIST OF FIGURES

1 INTRODUCTION

Savannah Environmental (Pty) Ltd has been appointed as the independent Environmental Consultant by Moeding Solar (Pty) Ltd to undertake the Basic assessment process according to the EIA Regulation of 2014 (as amended) and GN114 for the Moeding Solar PV Facility as well as the associated grid connection, approximately 10km south of Vryburg, North West Province. The proposed development project is located within the Naledi Local Municipality and Dr Ruth Segomotsi Mompati District Municipality.

The following properties form part of the Moeding Solar PV Facility project site as well as the associated grid connection (Fig. 1):

- Portion 1 of the farm Champions Kloof 731,
- Portion 4 of the farm Waterloo 730,
- the Remaining Extent of Portion 3 of the Farm Waterloo 730
- and Remainder of the farm Rosendal 673

The proposed facility include multiple arrays (static or tracking) of photovoltaic (PV) solar panels with a generating capacity of up to 100MW and the development footprint of the facility is anticipated to be approximately 300 ha in extent.

1.1 Infrastructure

Infrastructure associated with the Moeding Solar PV Facility include:

- Arrays of PV panels (static or tracking PV system) with a capability of up to 100MW.
- Mounting structures to support the PV panels.
- Cabling between the projects components (underground where practical).
- Offices and workshop areas for maintenance and storage.
- On-site inverters to convert the power from a direct current to an alternating current
- An on-site substation to facilitate the connection between the solar energy facility and the Eskom electricity grid.
- A new 132kV power line between the on-site substation and the Eskom grid connection point.
- Battery storage with up to 6 hours of storage capacity.
- Temporary laydown areas.
- Permanent laydown area.
- Internal access roads and fencing.

The project site is located within Zone 6 of the Renewable Energy Development Zones (REDZ), which is also known as the Vryburg REDZ. Due to the location of the project site within the REDZ, a Basic Assessment (BA) process will be undertaken in order to acquire Environmental Authorisation.

The power line corridor will be situated within the Remaining Extent of the Farm Rosendal 673 and the Remaining Extent of Portion 3 of the Farm Waterloo 730. Two grid connection alternatives are being considered:

- **Alternative 1** – a direct connection to the existing Mookodi Main Transmission Substation located north of the project site on the Remaining Extent of the Farm Rosendal 673. A new 132kV power line will be constructed over a distance of ~4km. A 300m power line corridor has been assessed for Alternative 1.
- **Alternative 2** - a turn-in turn-out connection into the proposed Mookodi - Magopela 132kV power line (to be constructed along the eastern boundary of the project site). A new turn-in and out 132kV power line will be constructed over a distance of ~335m.

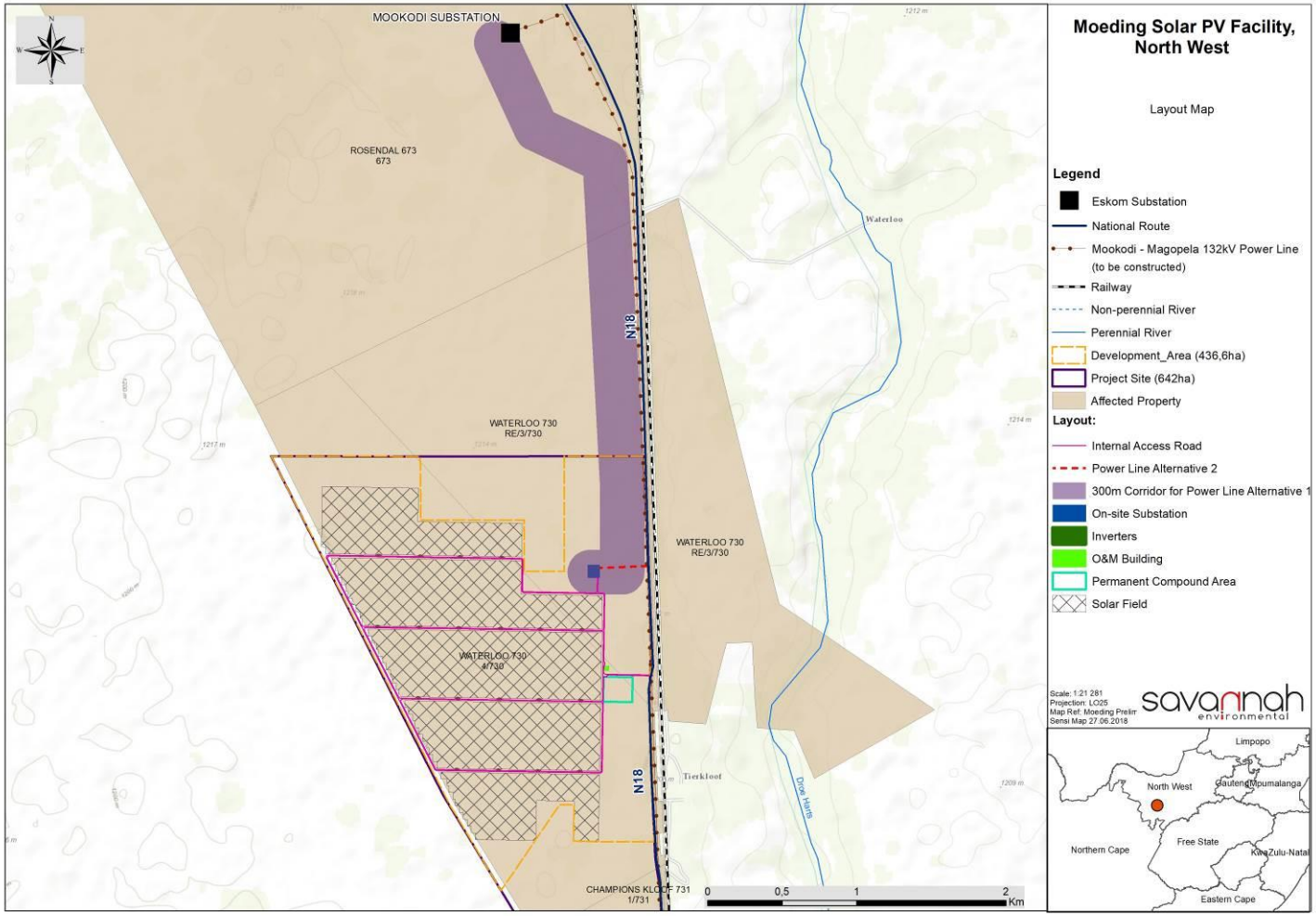


Figure 1: Moeding Solar PV Facility and associated infrastructure, North West Province. Map provided by Savannah Environmental

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty five years. She has been conducting Palaeontological Impact Assessments since 2014.

3 LEGISLATION

Cultural Heritage in South Africa, including 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**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, moved, broken 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 m^2 in extent;

or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority

4 OBJECTIVE

The objective of a Palaeontological Desktop Assessment is to determine the impact of the development on potential palaeontological material at the project 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.

When conducting a palaeontological desktop study, 1:250 000 geological maps are used to identify the potentially fossiliferous rocks present within the study area. Topography maps (1:50 000) as well as Google Earth Images are used to identify the topography of the development footprint. Previous palaeontological impact studies conducted in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations in areas close to the development area) are utilized in identifying fossil heritage within each rock section. The possible impact of the proposed development footprint on local fossil heritage is then calculated based on the following criteria: 1) the palaeontological importance of the rocks underlying the development 2) quantity of bedrock excavated and 3) the type of the development footprint.

A field-based assessment by a professional palaeontologist is necessary when rocks of moderate to high palaeontological sensitivity are present within the study area. Then, based on the available data of the desktop study and field inspection of the rock exposures, the impact significance of the planned development is measured with recommendations for further studies or mitigation. Generally destructive impacts on palaeontological heritage only occur during construction. The excavations will transform the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation comprises the collection and recording of fossils and usually precedes construction, although it may be implemented during construction when potentially fossiliferous bedrock is exposed. It is important to note that preceding the excavation of any fossil heritage, a permit from SAHRA must be obtained and the material must be

housed in a permitted institution. When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

5 BACKGROUND TO THE GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The Moeding Solar Facility's grid connection is situated in the northern part of the project development area and is underlain by the Vryburg Formation of the Transvaal Supergroup, while the Moeding Solar PV facility is underlain by the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup (Fig. 2-3). A small portion of the development area however, is also situated in the Vryburg Formation (Fig. 3).

The Vryburg Formation consists of shallow marine or lagoon sediments as well as volcanic rocks. This formation is approximately 140 m thick and overlies the Ventersdorp Supergroup lavas. The lower portion of the Vryburg series comprises of basal conglomerates followed by the 20 m thick Kobaga beds represented by prominent weathering of cross-bedded feldspathic quartzites. The Kobaga beds in turn are overlain by approximately 20 m andesitic or basaltic lavas of the Rosendal Member and by the Waterloo Member which consists of approximately 20-50m of amydaloidal and non-amydaloidal basaltic or andesitic lavas.

Microbial stromatolites in the upper Vryburg Formation were described by Smith (1991). During their research Altermann and Wotherspoon, (1995) concluded that the stromatolitic carbonates are intertidal. To date, no detailed descriptions of the Vryburg stromatolite occurrences are present in the literature, although South African Archaean stromatolites have been discussed by various authors (Altermann, 2001; Buick, 2001; and Schopf, 2006). Columnar stromatolites from the Schmidtsdrif Subgroup of the Northern Cape have been described by Bertrand-Sarfarti and Eriksson (1977).

The Moeding Solar PV facility (Fig. 3) is underlain by ancient sedimentary rocks of the Schmidtsdrif Subgroup. In the Griqualand West Basin, the Schmidtsdrif Subgroup is the basal subdivision of the Late Archaean to Early Proterozoic Ghaap Group (Transvaal Supergroup), Ghaap Plateau Sub-basin (Fig. 2). The Schmidtsdrif Subgroup can be divided into the geological older Boomplaas Formation and younger Clearwater Formation. The Boomplaas Formation, consists of superficial marine carbonates which comprise mainly of siliclastic sediments and dolomites. This sequence is the transition between the continental Vryburg beds and the marine Campbell Rand platform carbonates of the Kaapvaal Craton. The combination of dolomites and siliclastic sediments is approximately 100–185 m in thickness. The Boomplaas Formation is characterized by grey dolomites that weathers to a reddish-brown with subsidiary interbeds of limestone which in turn weathers to blue-grey, sandstone and shale as well as quartzite. The Ghaap Group represents 200 million years of chemical sedimentation which is represented by iron and manganese ores, carbonates and cherts. The Clearwater Formation is the uppermost sub-unit of the Schmidtsdrif Subgroup. The

pyritic and calcitic, mudrocks are black while the carbonates may exhibit crinkly stromatolitic textures.

The proposed Moeding Solar PV Facility site (and grid connection site) near Vryburg comprises of the characteristic flat-lying terrain of the Ghaap Plateau region. The development area is presently used for agricultural purposes, primary cattle farming and grazing. The areas assessed for the 2 alternative grid connections have longer grasses as it is not as actively grazed as that of the Moeding Solar PV Facility. The climate is semi-arid and the vegetation cover of grassy thornveld is mapped as Ghaap Plateau Vaalbosveld. Small, low and scattered bedrock exposure may be present on the project site, but the literature states that the exposures are rare apart from along river banks and steeper hill slopes (Almond, 2013). Images from Google Earth show a flat relief and bedrock mantled by reddish-brown soils.

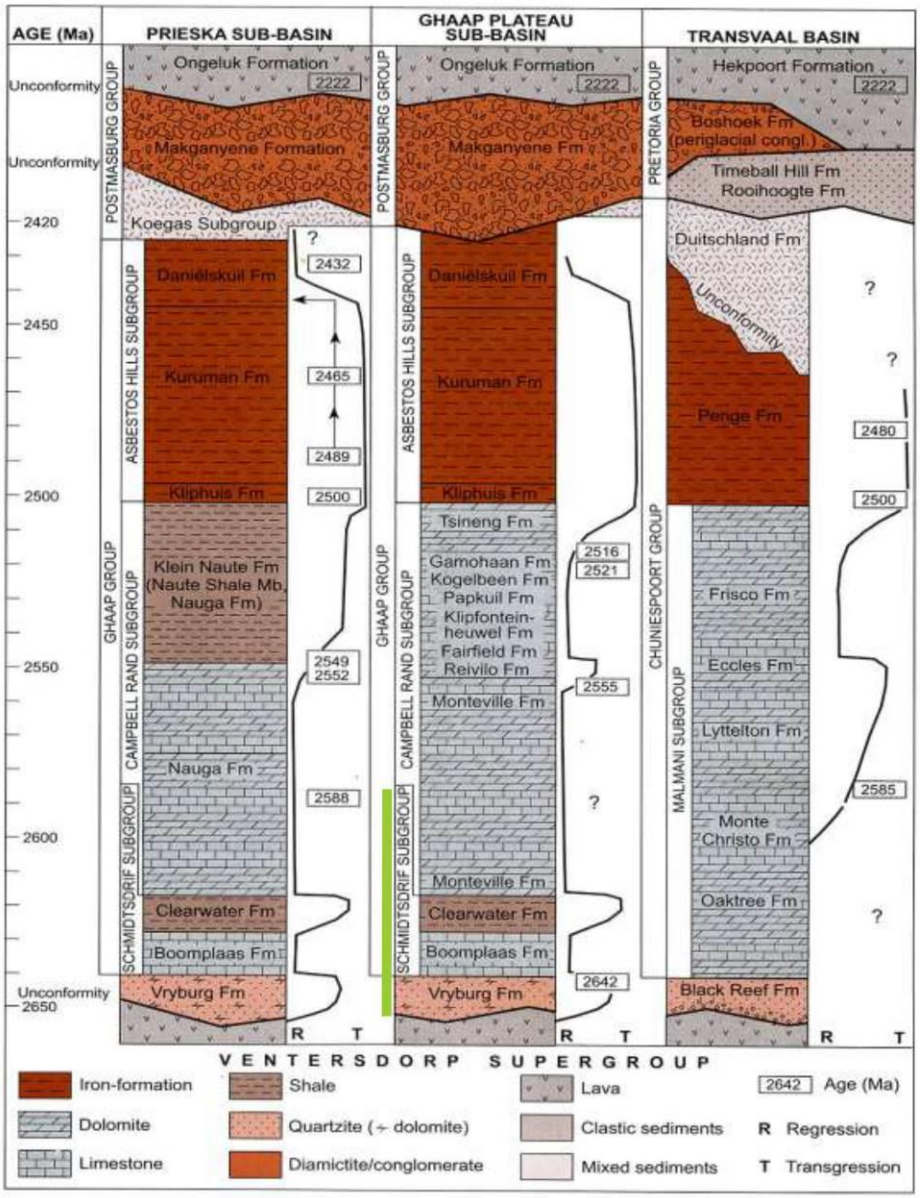


Figure 2: Stratigraphy of the Transvaal Supergroup of the Ghaap Plateau Basin. The middle column shows the rock units represented in the proposed study area (green line) (Eriksson, *et al.* 2006). The Vryburg Formation is incorporated within the base of the Schmidtsdrif Subgroup by some recent authors and is no longer correlated with the Black Reef Formation of the Transvaal Basin as shown here (*e.g.* Altermann and Wotherspoon, 1995, Sumner and Beukes, 2006)

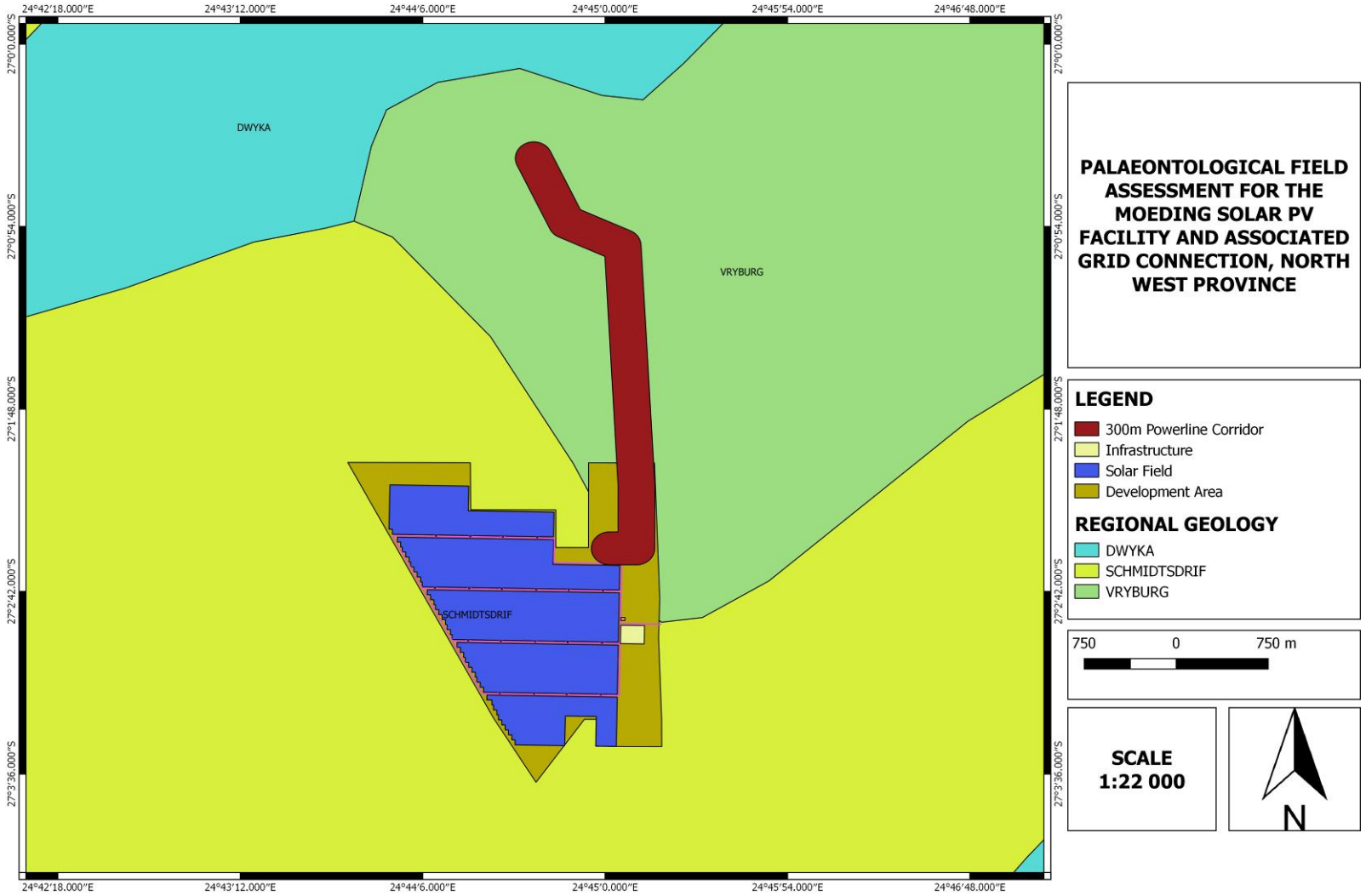


Figure 3: The surface geology of the proposed construction of the Moeding Solar and grid connection, near Vryburg, North West Province. The site is underlain by the Vryburg Formation (Transvaal Supergroup) and the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup. Map was drawn by QGIS Desktop 2.18.18.

Figure 4: Example of a well preserved stromatolite from the Archaean Era. (www.fossilmuseum.net/Tree_of_Life/Stromatolites.htm).

Stromatolites are layered mounds, columns and sheet-like sedimentary rocks. 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. The oxygen atmosphere that we depend on was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

6 GEOGRAPHICAL LOCATION OF THE SITE

The project site is 642 ha in extent and located within the Naledi Local Municipality and Dr Ruth Segomotsi Mompati District Municipality. The proposed development project is situated on the following farms:

- Portion 1 of the farm Champions Kloof 731,
- Portion 4 of the farm Waterloo 730,
- the Remaining Extent of Portion 3 of the Farm Waterloo 730
- and Remainder of the farm Rosendal 673

Twenty three similar solar facilities (SEF) are in the process of construction or has been completed in the Vryburg area (Fig. 5).

7 METHODS

As part of the Palaeontological Impact Assessment, a one day field-survey of the project site and power line corridor was conducted on the weekend of the 30 th of June 2018 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot and by vehicle within the proposed project site. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2018), topographical and geological maps were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

7.1 Assumptions and limitations

The accurateness of Palaeontological Desktop Impact Assessments is reduced by old fossil databases that do not always include relevant locality or geological formations. The geology in various remote areas of South Africa may be less accurate because it is based entirely on aerial photographs. The accuracy of the sheet explanations for geological maps is inadequate as the focus was never intended to be on palaeontological material.

The entirety of South Africa have not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area.

Thus, the accuracy of the Palaeontological Impact Assessment will be improved by a field-survey.

In order to ensure that an accurate description of the area proposed for the development is considered, a field survey was undertaken to ground truth any potential impacts that the facility may have on the palaeontological resources of the site. The field-survey was undertaken on 1 July 2018, as indicated above.

7.2 Additional Information Consulted

In compiling this report the following sources was consulted:

- The Palaeosensitivity Map from the SAHRIS website.
- 1:250 000 geological maps: 2724 Christiana and 2624 Vryburg.
- A Google Earth map with polygons of the proposed development was obtained from SAVANNAH.

A Palaeo-technical report conducted by Almond in 2013 on a nearby farm in the Vryburg REDZ.

- ALMOND, J.E. (2013) Palaeontological Heritage Assessment for the proposed PV Solar Facility on a portion of the farm Waterloo 992 near Vryburg, Naledi Local Municipality, North-West Province, SAHRA.).
    - In this report the author mentioned beautifully preserved stromatolite specimens on the farm Waterloo 992, east of the Moeding Solar PV Facility.

A Heritage Management plan for the preservation of the above mentioned stromatolites on Waterloo 992 was compiled in 2018.

- MULLER, C., AND ORTON, J. 2018. Heritage Management Plan for the protection of stromatolites at the Waterloo Solar PV facility on Waterloo 992-in, Vryburg Magisterial District, Northwest Province. ASHA Consulting. Cape Town.

8 FIELD OBSERVATIONS

The following photographs were taken during the site visit to the project site proposed for the Moeding Solar PV Facility near Vryburg, North West Province. No fossils were uncovered on the farm Rosendal 673 (where the grid connection is planned) but numerous stromatolite assemblages were uncovered loose as well as *in situ* southwards, on the Portion 1 of the farm Champions Kloof 731, Portion 4 of the farm Waterloo 730, and Remaining Extent of Portion 3 of the farm Waterloo 730 where the proposed solar farm is proposed. Portion 4 of the farm Waterloo 730 will be of importance for the development of the Moeding Solar PV facility as mitigation will occur in this area.

Figure 5: Typical flat topography of the Ghaap Plato development footprint. Vegetation cover is fairly dense. 27° 02′ 13”S; 24°44′44”E

Figure 6: Conglomerate. 27° 02’ 24”S; 24°44’10”E

Figure 7: Isolated loose stromatolite. 27° 02’ 23”S; 24°44’39”E

Figure 8: Weathered stromatolite found loose on the surface. 27° 02’ 26”S; 24°44’42”E

Figure 9: Loose stromatolite. 27° 02’ 23”S; 24°44’40”E

Figure 10: Weathered *in situ* domal structures of stromatolite seen from above. 27° 02’ 43”S; 24°45’03”E

Figure 11: Mookodi Substation about 4.5km north of the project site. Note the characteristic flat-lying terrain with the vegetation cover of grassy thornveld. No outcrops are present

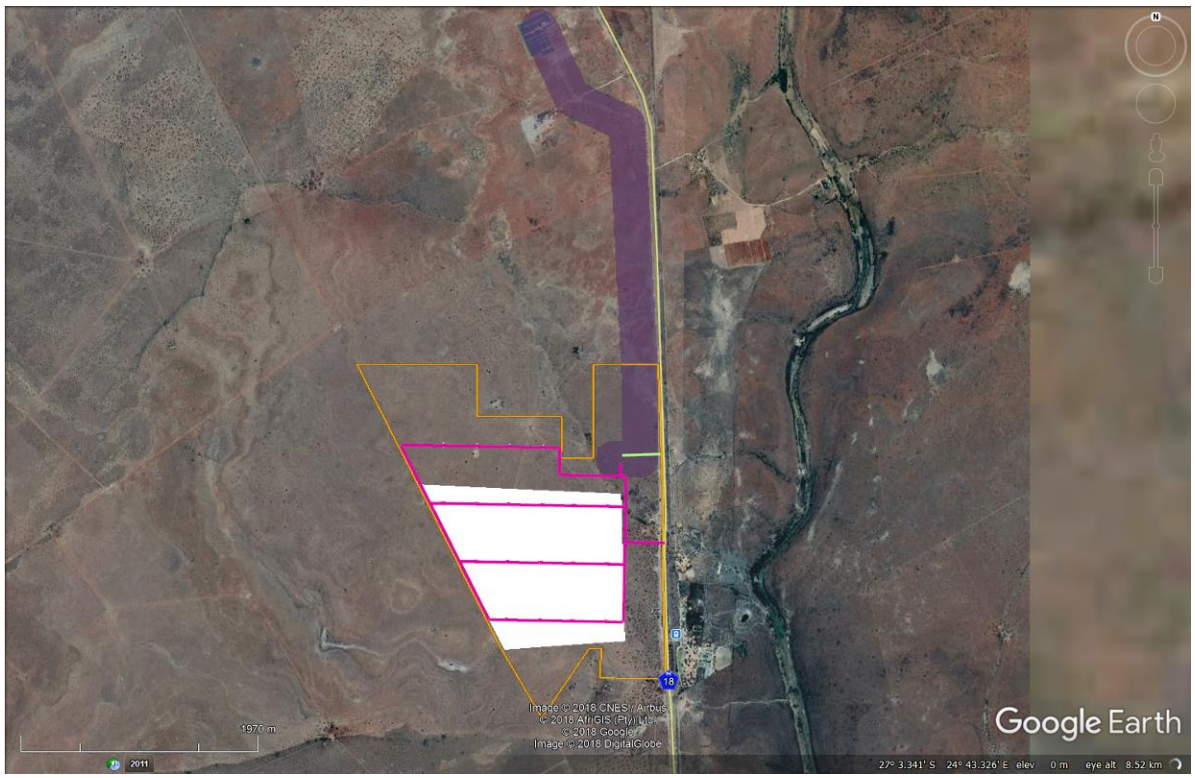
Figure 12: Flat topography of the proposed power line corridor near Vryburg

Figure 13: Vegetation on the proposed Moeding grid development project. Fossiliferous outcrops were not identified**.**

9 FINDINGS

The Moeding Solar Facility's grid connection is situated in the northern part of the project area and is underlain by the Vryburg Formation of the Transvaal Supergroup, while the Moeding Solar PV facility is underlain by the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup (Fig. 2-3). A small portion of the development area however, is also situated in the Vryburg Formation (Fig. 3).

The proposed Moeding Solar PV Facility site (and grid connection site) near Vryburg comprises of the characteristic flat-lying terrain of the Ghaap Plateau region. The development area is presently used for agricultural purposes, primary cattle farming and grazing. The climate is semi-arid and the vegetation cover of grassy thornveld is mapped as Ghaap Plateau Vaalbosveld. Small, low and scattered bedrock exposure may be present on the project site, but the literature states that the exposures are rare apart from along river banks and steeper hill slopes (Almond, 2013). Images from Google Earth show a flat relief and bedrock mantled by reddish-brown soils.



Google Earth (2018) image of the proposed Moeding Solar PV facility area as well as associated grid connection. During a site visit in June 2018 fossils were uncovered in the area indicated in white. Scale bar represent 1970 km.

Stromatolite fossils were found on the following farms:

- Portion 1 of the farm Champions Kloof 731,
- Portion 4 of the farm Waterloo 730,
- the Remaining Extent of Portion 3 of the Farm Waterloo 730

Portion 4 of the farm Waterloo 730 will require mitigation.

Stromatolites occur in fast areas of the central interior of South Africa and is not considered to be so scarce that every stromatolite must be preserved. However it is very important that exceptional stromatolite assemblages must be preserved. Some visible stromatolite assemblages were identified during this site visit but following vegetation clearance a qualified palaeontologist must conduct a site visit to determine if extraordinary stromatolites can be preserved. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution.

No fossil heritage was recovered from the Remainder of the farm Rosendal 673, but there is a possibility that stromatolites may occur. Thus a chance find procedure have been added to the report.

10 CHANCE FIND PROTOCOL

- When a chance find is made the person must instantly stop all work near the find.
- The site must be secured to protect it from any additional damage.
- The finder of the fossil heritage must immediately report the find to his/her direct supervisor, according to the reporting protocols instituted by the development management. The supervisor must in turn report the find to his/her manager and the ECO. The ECO must report the find to the relevant Authorities and a relevant palaeontologist.
- The ECO must appoint a relevant palaeontologist to investigate and access the chance find and site.
- Both ECO and palaeontologist must ensure that accurate records and documentation are kept. The documentation must start with the initial chance find report, including records of all actions taken, persons involved and contacted, comments received and findings.
- These documents will be necessary to request authorizations and permits from the relevant Authorities to continue with the work on site.
- The reports and all other documents will be submitted to SAHRA by the palaeontologist.
- The report will include recommendations for additional specialist work if necessary, or request approval to continue with the development.
- When the necessary approvals have been issued, the development may carry on with the development.

The ECO will close off the chance find procedure and would be required to implement any requirements issued by the Authority and to add it to the operational management plan.

11 Assessment Methodology

Direct, indirect and cumulative impacts of the impacts identified above will be assessed according to the following standard methodology:

- The **nature** which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent** wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration** wherein it will be indicated whether:
    - The lifetime of the impact will be of very short duration (0 - 1 years) – assigned a score of 1;
    - The lifetime of the impact will be of short duration (2 - 5 years) – assigned a score of 2;
    - Medium-term (5 - 15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.
- The **magnitude** quantified on a scale from 0 - 10 where 0 is small and will have no effect on the environment, 2 is minor and will result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease) and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 - 5 where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but of low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance** which shall be determined through a syntheses of the characteristics described above and can be assessed as low, medium or high; and
- The **status**, which is described as positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

$S = (E + D + M) \times P$

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area);
- 30 – 60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated); and
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

12 IMPACT ASSESSMENTS

An assessment of the impact significance of the proposed Moeding Solar PV Facility on: Portion 1 of the farm Champions Kloof 731, Portion 4 of the farm Waterloo 730, Remaining Extent of Portion 3 of the farm Waterloo 730 is presented here:

12.1 Nature of the impact

The excavations and site clearance of the Moeding Grid connection and the Moeding Solar Facility will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may destroy or permanently seal-in fossils at or below the ground surface that will no longer be available for scientific research. According to the Geology of the project site there is a possibility of finding stromatolites (laminated microbial mounds).

12.2 Sensitive areas

The Moeding Solar Facility's grid connection is situated in the northern part of the development area and is underlain by the Vryburg Formation of the Transvaal Supergroup, while the Moeding Solar PV facility is underlain by the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup. A small portion of the development area however, is also situated in the Vryburg Formation.

During a site visit stromatolite assemblages were recorded within the Schmidtsdrif Subgroup while no fossils were recorded in the Vryburg Formation although there is a possibility that fossils could be present in this geological formation.

12.3 Geographical extent of impact

The impact on fossil materials and thus palaeontological heritage will be limited to the construction phase when new excavations into fresh potentially fossiliferous bedrock take place. The extent of the area of potential impact is thus restricted to the project site and therefore categorised as **local**.

12.4 Duration of impact

The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be **permanent.**

12.5 Potential significance of the impact

Should the project progress without due care to the possibility of fossils being present at the proposed development site within the Vryburg Formation the resultant damage, destruction or inadvertent relocation of any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the development area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

12.6 Severity / benefit scale

The development of the proposed Moeding Solar PV Facility is **beneficial** on not only a local level, but regional and national levels as well. The facility will provide a long term benefit to the community in terms of the provision of electricity to a progressively stressed national electricity grid.

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils that were hidden beneath the surface exposures and, as such, would have remained unknown to science.

12.7 Intensity

Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as medium.

12.8 Probability of the impact occurring

Since concentrations of small to large stromatolites are recorded within the proposed development site, the probability of significant impacts on palaeontological heritage during the construction phase are high (definite).

13 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

13.1 Mitigation

In the event that fossil material exist within the proposed development area any negative or detrimental impact upon it could be mitigated by describing and collecting well-preserved fossils by a professional palaeontologist. This actions should take place after vegetation clearance has taken place but *before* the ground is levelled for construction. Excavation of fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.

13.2 Degree to which the impact can be mitigated

Recommended mitigation of the damage and destruction of fossil stromatolites within the proposed development area would involve the collection and describing of fossils within the development footprint by a professional palaeontologist. This actions would take place after initial vegetation clearance has taken place but *before* the ground is levelled for construction.

13.3 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. From a scientific point of view all well-documented records and palaeontological studies of any fossils exposed during construction would represent a positive impact. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category.

13.4 Degree to which the impact may cause irreplaceable loss of resources

Stratigraphic and geographical distribution of Late Archaean stromatolites within the Schmidtsdrif Subgroup and Vryburg Formation of the Transvaal Supergroup is present in the development footprint. By taking a precautionary approach, a significant loss of fossil resources is expected.

Table 1: Impact table of the construction phase of the Moeding Solar PV facility

Nature: *T*he excavations and clearing of vegetation during the construction phase of the **Moeding PV solar facility** will consist of digging into the superficial sediment cover as well as

underlying deeper bedrock. These excavations will change the existing topography and may possibly destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.

Impacts on Palaeontological Heritage are only likely to happen within **the construction phase**. No impacts are expected to occur during the operation phase or decommissioning phase.

	Without mitigation	**With mitigation**
Extent	Local(1)	Local(1)
Duration	Long term/permanent (5)	Long term/permanent (5)
Magnitude	Moderate (6)	Minor (1)
Probability	Probable (4)	Very Improbable (1)
Significance	**Medium (48)**	**Low (7)**
Status (positive or negative)	Negative	Neutral
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation: Necessary

Poorly- to fairly well-preserved, stromatolite assemblages were detected on Portion 4 of the farm Waterloo 730 and Remaining Extent of Portion 4 of the farm Waterloo 730. These fossils finds were loose as well as *in situ*. Mapping of the stromatolites identified within the project site was very difficult due to the vegetation and gravelly soil. However, after clearing of vegetation had taken place the possibility of uncovering well-preserved stromatolite fossils will be enhanced.

Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the proposed development footprint by a palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme for the Moeding Solar PV Facility project.

Residual Risk:

Loss of Palaeontological Heritage.

Table 2: Impact table of the construction phase of the Power line Alternative 1 and 2

Nature: *T*he excavations and clearing of vegetation during the construction phase of the **Moeding grid connection** will consist of digging into the superficial sediment cover as well as underlying deeper bedrock. These excavations will change the existing topography and may possibly destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.

Impacts on Palaeontological Heritage are only likely to happen within **the construction phase**. No impacts are expected to occur during the operation phase or decommissioning phase.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local(1)	Local(1)	Local(1)	Local(1)
Duration	Long term/permanent (5)	Long term/permanent (5)	Long term/permanent (5)	Long term/permanent (5)
Magnitude	Moderate (2)	Moderate (1)	Moderate (2)	Moderate (1)
Probability	Improbable (2)	Improbable (1)	Improbable (2)	Improbable (1)
Significance	**LOW (16)**	**LOW (7)**	**LOW (16)**	**LOW (7)**
Status (positive or negative)	Negative	Neutral	Negative	Neutral
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	No	Yes	No
Can impacts be mitigated?	Yes		Yes	

Mitigation: Chance find procedure

- When a chance find is made the person must instantly stop all work near the find.
- The site must be secured to protect it from any additional damage
- The finder of the fossil heritage must immediately report the find to his/her direct supervisor, according to the reporting protocols instituted by the development management. The supervisor must in turn report the find to his/her manager and the ECO. The ECO must report the find to the relevant Authorities and a relevant palaeontologist.
- The ECO must appoint a relevant palaeontologist to investigate and access the chance find and site.
- Both ECO and palaeontologist must ensure that accurate records and documentation are kept. The documentation must start with the initial chance find report, including

records of all actions taken, persons involved and contacted, comments received and findings. • These documents will be necessary to request authorizations and permits from the relevant Authorities to continue with the work on site • The reports and all other documents will be submitted to SAHRA by the palaeontologist. • The report will include recommendations for additional specialist work if necessary, or request approval to continue with the development. • When the necessary approvals have been issued, the development may carry on with the development. The EO will close off the chance find procedure and would be required to implement any requirements issued by the Authority and to add it to the operational management plan
Residual Risk: *Loss of Fossil Heritage*

13.5 Cumulative impacts

The Moeding Solar PV project is located within Zone 6 of the Renewable Energy Development Zones (REDZ). This area is also known as the Vryburg REDZ. Due to the location of the Moeding Solar PV Facility within the REDZ, a Basic Assessment (BA) process will be undertaken in order to acquire Environmental Authorisation.

To date twenty three known solar projects and their individual grid connections, other than the proposed development are located within a 30km radius from the Moeding Solar PV Facility development site (Figure 4). These include the following authorized projects and does not include the projects currently in the process of obtaining authorization:

Project Name	Location	Approximate distance from the project site	Project Status
Sonbesie Solar Power Plant	Remaining Extent of the farm Retreat 671	6,2km north west of the site	Authorised
Sediba Solar Energy Facility (Rosendal)	Remaining Extent of the Farm Rosendal 673	Located within the project site	Authorised
Protea Solar Power Plant	Remaining Extent of the farm Hartsboom 734	Located adjacent (west)	Authorised
Waterloo Solar Park	Remaining Extent of Farm Waterloo 992	Located adjacent (east)	Authorisation granted (Preferred Bidder Round 4)
Khubu Solar Power Plant	Portion 5 of Championskloof 731	Located adjacent (south east)	Authorised
Gamma Solar Power Plant	Portion 4 Championskloof	5,9km east of the site	Authorised
Sendawo PV 1 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 2 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 3 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised

Tiger Kloof Solar Energy Facility	Remaining Extent of Portion 3 and Portion 4 of the Farm Waterloo 730	Located within the project site	Authorised
Woodhouse Solar 1 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Woodhouse Solar 2 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Alpha Solar Power Plant	Remaining Extent of farm Middelpan 605	30km west of the site	Authorised
Klondike PV1 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV2 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV3 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Meerkat Solar Power Plant	Portion 3 of Vyflings Pan 598	28,5km west of the site	Authorised
Carocraft Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised
60MW Carocraft PV Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised
Renewable Energy Generation Project		22.5km north of the affected properties	Authorised
Vryburg Solar 1	Portion 2 of Farm	5km west of	Authorised

	Frankfort 672	the site	
Vryburg Solar 2	Portion 1 of Farm Retreat 671	7.7km north west of the site	Authorised
Vryburg Solar 3	Portion 1 of Farm Retreat 671	8.3km north west of the site	Authorised

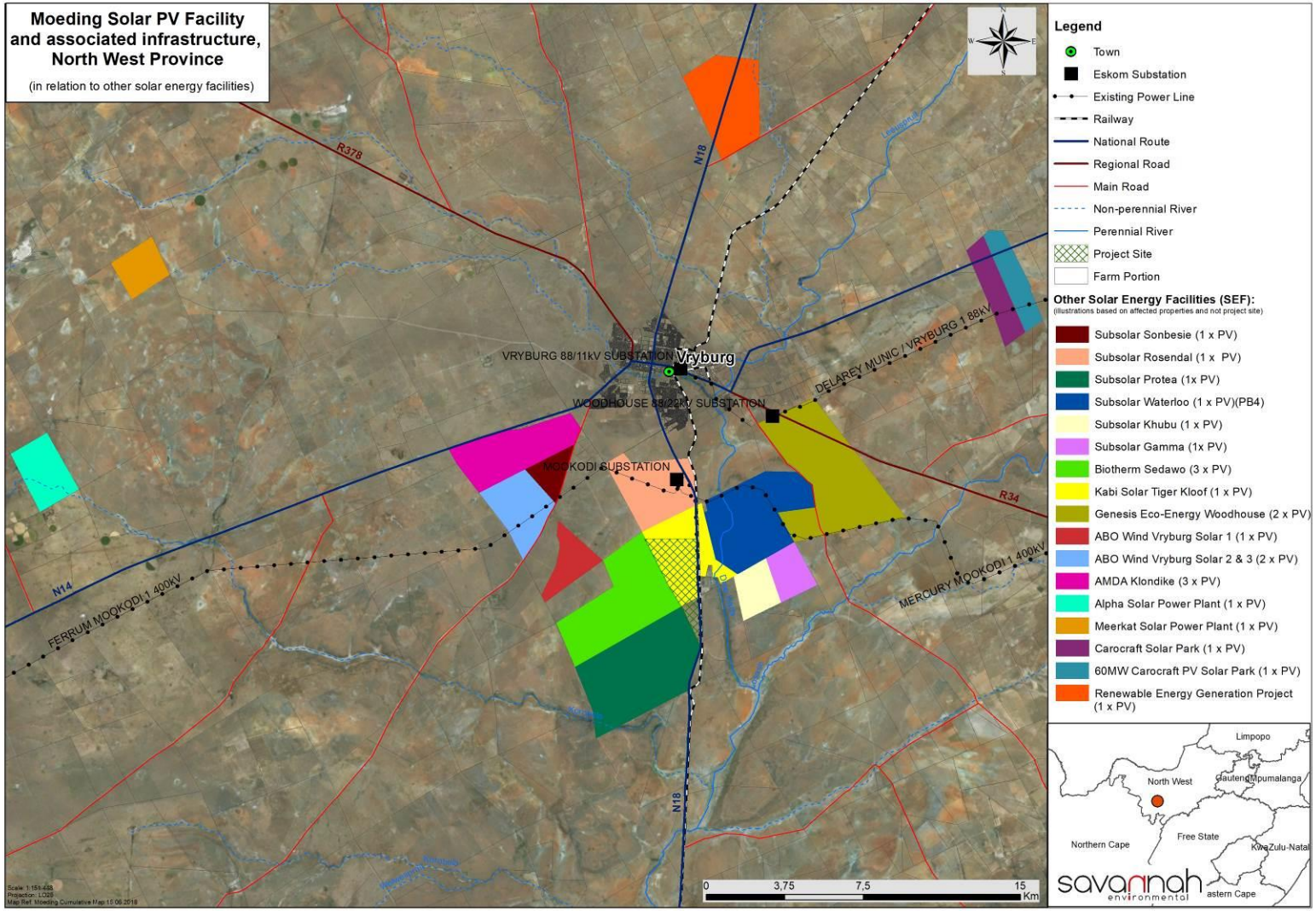


Figure 4: Moeding Solar PV facility in associated with other solar energy projects in the Vryburg Area, North West Province. Map provided by Savannah Environmental.

ASSESSMENT OF CUMULATIVE IMPACTS

Stratigraphic and geographical distribution of Late Archaean stromatolites within the Schmidtsdrift Subgroup and Vryburg Formation of the Transvaal Supergroup is present in the development footprint and the surrounding area. Excavations and site clearance for Moeding Solar and other solar energy facilities within the surrounding area will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research. Any fossils occurring within the project site and surrounding area are potentially scientifically and culturally significant.

Nature: Cumulative impacts of solar projects, located within a 30km radius from the Moeding Solar PV Facility development site.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and** twenty three **other projects in the area**
Extent	Local (3)	Local (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (1)	Moderate (6)
Probability	Improbable (1)	Very Probable (4)
Significance	**Low (7)**	**Medium (56)**
Status (positive/negative)	Neutral	Negative
Reversibility	Irreversible	Irreversible
Loss of resources?	No	Unknown
Can impacts be mitigated?	Yes	Unknown
Confidence in findings: High.		
Mitigation: Necessary As the 23 different Solar Energy Facilities fall in the Vryburg REDZ, Basic Assessments is necessary for Environmental Authorization of the different projects. Each Project will have recommendations and when fossils are present in the development sites mitigation will be necessary.		

Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the proposed development footprints by a palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Moeding Solar PV Facility project and other solar energy facilities in the surrounding area.
Residual Risk: Loss of Palaeontological Heritage

The overall cumulative impact of the facility and associated infrastructure on the Palaeontological Heritage is considered to be low.

RECOMMENDATIONS CONCERNING FOSSIL HERITAGE MANAGEMENT DURING THE CONSTRUCTION PHASE

OBJECTIVE: Prevent the loss of Palaeontological Heritage			
Project component/s	Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography. The proposed development consists of the construction of the Moeding Solar PV Facility and associated infrastructure.		
Potential Impact	Destroy or permanently close-in fossils at or below the ground surface that are then no longer available for research.		
Activity/risk source	• Activities associated with the construction of the project.		
Mitigation: Target/Objective	Protection of identified fossils uncovered during the construction phase.		
Mitigation: Action/control		**Responsibility**	**Timeframe**
Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the		ECO	Construction phase

proposed development footprint by a palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme for the Moeding Solar PV Facility project.		

14 FINDINGS AND RECOMMENDATIONS

The Moeding Solar Facility's grid connection is situated in the northern part of the development project area and is underlain by the Vryburg Formation of the Transvaal Supergroup, while the Moeding Solar PV facility is underlain by the Schmidtsdrift Subgroup, Ghaap Group of the Transvaal Supergroup (Fig. 2-3). A small portion of the development area however, is also situated in the Vryburg Formation (Fig. 3).

The proposed Moeding Solar PV Facility site (and grid connection site) near Vryburg comprises of the characteristic flat-lying terrain of the Ghaap Plateau region. The development area is presently used for agricultural purposes, primary cattle farming and grazing. The climate is semi-arid and the vegetation cover of grassy thornveld is mapped as Ghaap Plateau Vaalbosveld. Small, low and scattered bedrock exposure may be present on the project site, but the literature states that the exposures are rare apart from along river banks and steeper hill slopes (Almond, 2013). Images from Google Earth show a flat relief and bedrock mantled by reddish-brown soils.

The two power line alternatives (1 and 2) for the grid connection is entirely underlain by the Vryburg Formation of the Transvaal Supergroup. During the site visit no fossils were recovered from the proposed grid sites and thus **no preferences on the grounds of palaeontological fossil heritage for any specific grid layout among the different options under consideration was identified. However, fossil assemblages were detected in the project site and thus mitigation is suggested.** Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the proposed development footprint by a

palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme for the Moeding Solar PV Facility project.

The construction and operation of the Moeding Solar PV Facility Power Project (also applicable to the two alternative powerlines) is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area **once** mitigation recommendations have been fully complied with.

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16 Appendix 1:

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 25 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

Registered as a PhD fellow at the Zoology Department of the UFS

2013 to current

Dissertation title: A new gorgonopsian from the uppermost D*aptocephalus Assemblage Zone*, in the Karoo Basin of South Africa

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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