



PGS HERITAGE

**PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED 990kWp
GROENHEUWEL SOLAR PLANT NEAR AUGRABIES, NORTHERN CAPE PROVINCE**

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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

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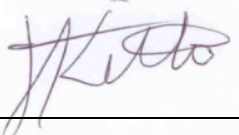
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ACKNOWLEDGMENT OF RECEIPT

Report Title	Palaeontological desktop assessment for the proposed 990 KWP Groenheuwel Solar Plant near Augrabies, Northern Cape Province		
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The heritage impact assessment report has been compiled taking into account 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.

NEMA Regs (2014) - Appendix 6	Relevant section in report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page ii of Report – Contact details and company and Appendix B
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page ii
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 4 – Objective
(cA) an indication of the quality and age of base data used for the specialist report;	Section 5 – Geological and Palaeontological history
(B) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 10
d) the date, duration and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A Desktop Study
e) a description of the methodology adopted in preparing the report or carrying out the specialized process inclusive of equipment and modeling used;	Section 7 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 and 11
g) an identification of any areas to be avoided, including buffers;	Not identified, Section 9
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 – Geological and Palaeontological history

NEMA Regs (2014) - Appendix 6	Relevant section in report
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – 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 or activities;	Section 11
k) any mitigation measures for inclusion in the EMPr;	Section 11
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; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 11
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 competent authority.	Not applicable.
2) Where a government notice <i>gazetted</i> 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 PGS Heritage (Pty) Ltd to conduct the **Palaeontological Desktop Assessment** (DIA) to assess the proposed 990 KWP Groenheuwel Solar Plant near Augrabies, in the Northern Cape. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), states that a Palaeontological Impact Assessment (PIA) is key to detect the presence of fossil material within the planned development footprint. This DIA is thus necessary to evaluate the effect of the construction on the palaeontological resources.

The proposed development is underlain by the ancient Precambrian granite -gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province which is mantled by the overlying Gordonia Formation of the Kalahari Group. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Kalahari Group is low and the ancient Precambrian granite -gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province is zero.

It is therefore considered that the construction and operation of the Groenheuwel Solar Plant, in the Northern Cape is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the EO in charge of these developments. These discoveries ought to be secured (preferably *in situ*) and the EO ought to alert SAHRA so that appropriate mitigation (e.g. documented and collection) can be undertaken by a professional palaeontologist.

The specialist would need a collection permit from SAHRA. Fossil material must be curated in an approved collection (museum or university) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

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TERMINOLOGY AND ABBREVIATIONS

Archaeological resources

This includes:

- material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artifacts, human and hominid remains, and artificial features and structures;
- rock art is any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- features, structures, and artifacts associated with a military history which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influences its stability and future well-being, including:

- construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- carrying out any works on or over or under a place;
- subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- constructing or putting up for display signs or boards;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil

Fossil

Mineralized bones of animals, shellfish, plants, and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa;

Holocene

The most recent geological time period which commenced 10 000 years ago.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Abbreviations	Description
ASAP	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DIA	Desktop Impact Assessment
EO	Environmental Officer
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Late Stone Age
LIA	Late Iron Age

Abbreviations	Description
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PIA	Palaeontological Impact Assessment
PHRA	Provincial Heritage Resources Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

1 INTRODUCTION

The development of a 990kWp Groenheuwel solar plant (Figure 1) of approximately 9800 m² and a 22kV power line approximately 6.5km in extent near Augrabies in the Northern Cape is proposed. A Desktop PIA is required as the extent of the solar plant exceeds 5000 m². The project does not trigger the requirement for an EIA process, in terms of NEMA or other similar legislation, but requires a desktop Palaeontological Assessment (as it exceeds 5000m²) and a response from the South African Heritage Resources Agency (SAHRA).

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-four years. She has extensive 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 for 12 years. She has been conducting PIAs since 2014.

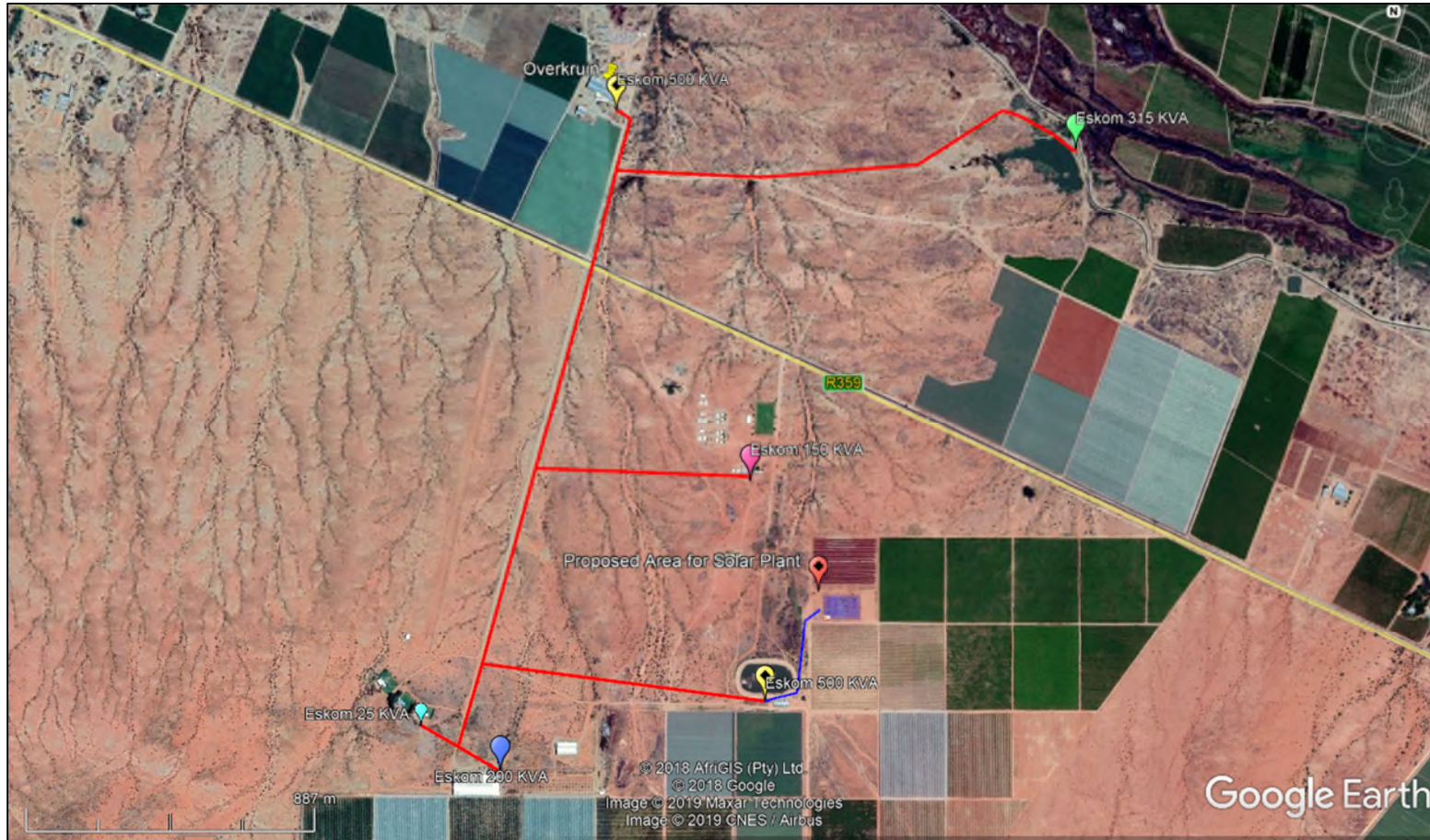


Figure 1: Google Earth Image of the proposed Groenheuwel Solar Plant, near Augrabies, Northern Cape Province

3 LEGISLATION

3.1 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**”.

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources 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 DIA 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 m² 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.

4 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 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).

5 GEOLOGICAL AND PALAEOLOGICAL HISTORY

The proposed Groenheuwel Solar development is located in a thinly vegetated fairly flat lying terrain. The sediments are mantled by red-brown sandy soils and gravels and are drained by ephemeral stream systems near the Orange River.

The proposed development is underlain by the ancient Precambrian granite-gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province, as well as the overlying Gordonia Formation of the Kalahari Group (Figure 2).

The ancient Precambrian granite -gneisses of the Namaqua-Natal Province are approximately 1.5 billion years old. These basement rocks are igneous in origin or highly metamorphosed (Almond & Pether 2009) and thus unfossiliferous (Cornell et al. 2006, Almond & Pether 2009). These rocks consist of amphibolites, gneisses, quartzites, and schists plus major granitic and gabbroic (norite) intrusions and are dated between 2050 and 1000 Ma (million years ago).

The Cenozoic Kalahari Group mantling the basement rocks, is approximately 65 – 2.5 million years old (Ma) and is the most widespread body of terrestrial sediments in southern Africa. The Cenozoic sands and calcretes of the Kalahari Group range in thickness from a few metres to more than 180m (Partridge et al., 2006). The youngest formation of the Kalahari group is the Gordonia Formation, which is generally termed Kalahari sand, and comprises red aeolian sands that cover most of the Kalahari Group sediments. The pan sediments of the area originated from the Gordonia Formation and contain white to brown fine grained silts, sands and clays. Some of the pans consist of clayey material mixed with evaporates that show the seasonal effects of shallow saline groundwaters. Quaternary alluvium, aolian sands, surface limestone, silcrete, and terrace gravels are also included in the Kalahari Group (Kent 1980).

The fossil assemblages of the Kalahari are generally very low in diversity and occur over a wide range and thus the palaeontological diversity of this Group is low. These fossils represent terrestrial plants and animals with a close resemblance to living forms. Fossil assemblages include bivalves, diatoms, gastropod shells, ostracods and trace fossils. Late Cenozoic calcrete may comprise of bones, horn cores as well as mammalian teeth. Tortoise remains have also been uncovered as well as trace fossils, which include termite and insect's burrows and mammalian trackways. Amphibian and crocodile remains have been uncovered where the depositional settings in the past were wetter.

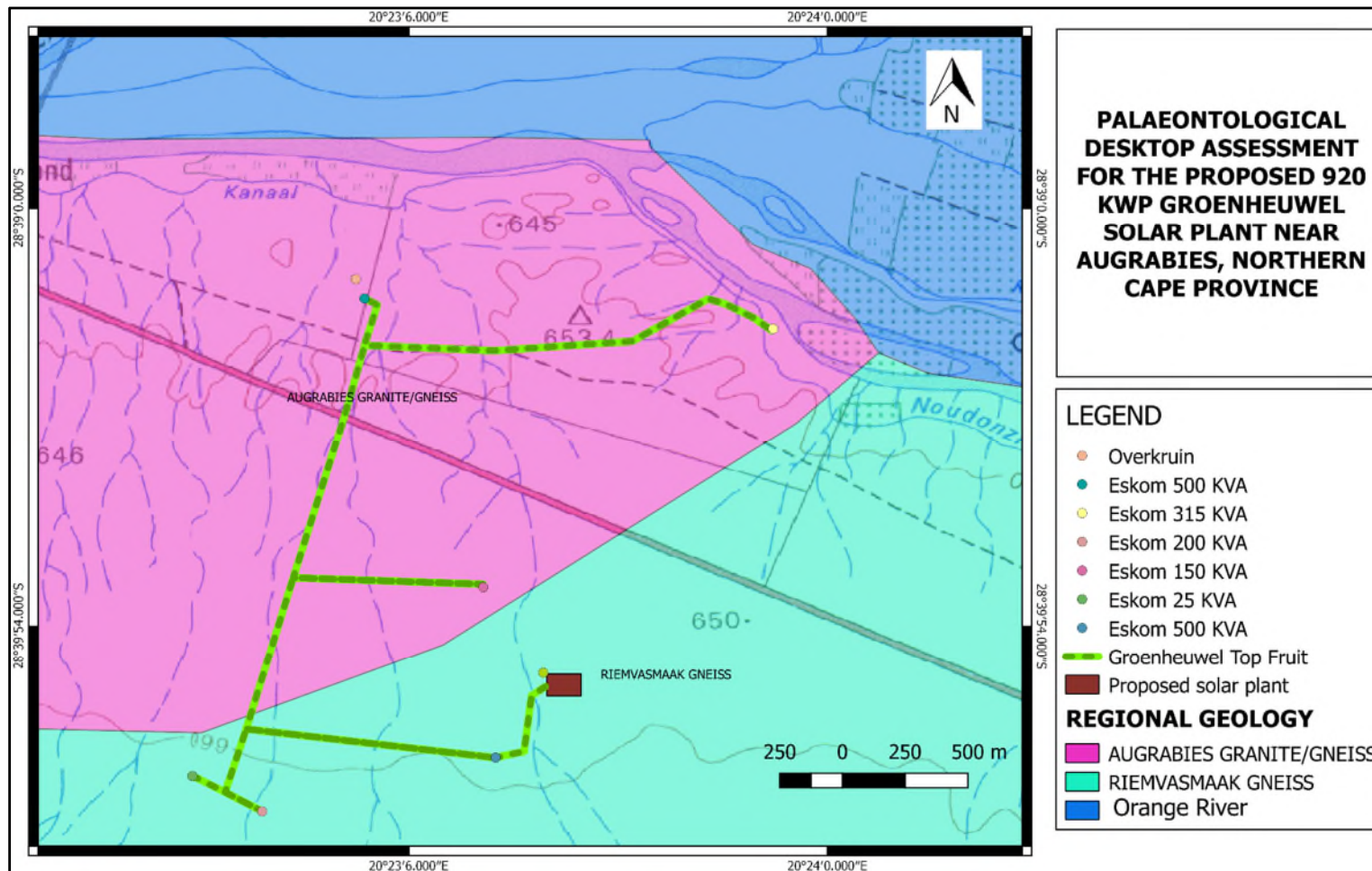


Figure 2: Surface geology of the proposed Groenheuwel Solar development near Augrabies in the Northern Cape is underlain by the Augrabies Granite Gneiss and Riemvasmaak Gneiss as well as overlying Gordonia Formation of the Kalahari Group. Map drawn by QGIS 2.18.28.

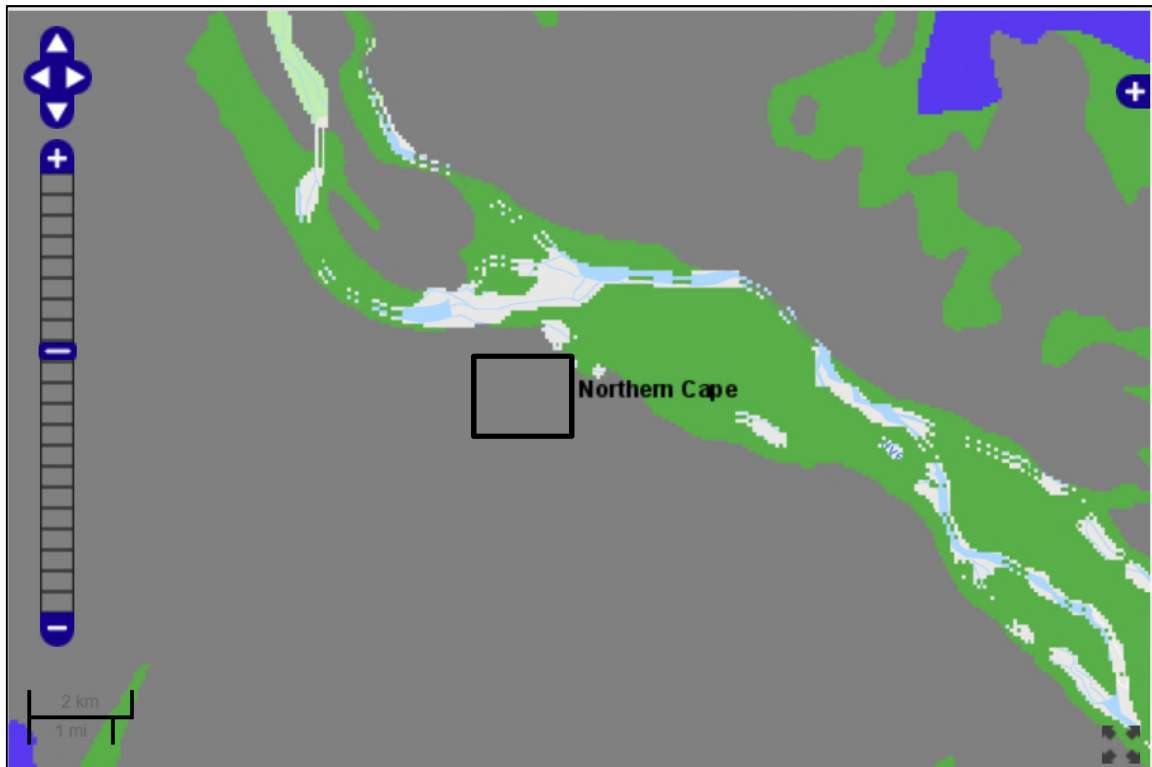


Figure 3: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences).
Approximate location of the proposed development is indicated by the black polygon.

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 3) there is zero to very low (insignificant) chance of finding fossils in this area.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Groenheuwel Solar development is situated approximately 10 km from Augrabies on the R359 in the Northern Cape .

7 METHODS

A desktop study was assembled to evaluate the possible risk to palaeontological heritage (this includes fossils as well as trace fossils) in the proposed development area. In compiling the desktop report aerial photos, Google Earth 2018, topographical and geological maps and other reports from the same area as well as the author's experience were used to assess the proposed development footprint.

7.1 Assumptions and Limitations

The accuracy of DIA is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information were not accurately documented in the past. Various remote areas of South Africa have not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentrate on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas are used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally **assume** that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

8 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 PGS Consultants.
- 1:50 000 Topographical Map 2820 CB
- PIA near the development site consulted include Almond 2012; 2018. See references.

9 CHANCE FINDS PROTOCOL

The following procedure will only be required if fossils are uncovered during excavation.

9.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 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 are 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.

9.2 Background

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past 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.

9.3 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 Officer (EO) 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 EO, 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.

9.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work 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 EO or site manager. The EO 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 3) a 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 EO (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 their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage authority 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 EO (site manager). 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 authority has issued the written authorization, the developer may continue with the development.

10 IMPACT 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).

10.1 IMPACT ASSESSMENTS

An assessment of the impact significance of the Groenheuwel Solar Plant near Augrabies, Northern Cape is presented here:

10.1.1 Nature of the impact

The excavations and site clearance of the Groenheuwel Solar Plant will involve excavations into the superficial sediment cover as well as 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 and will no longer be available for research. According to the Geology of the project site there is a zero to low possibility of finding fossils.

10.1.2 Sensitive areas

The proposed development is underlain by the ancient Precambrian granite-gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province as well as the overlying Gordonia Formation of the Kalahari Group. The Namaqua-Natal Province has a zero Palaeontological Sensitivity while the Kalahari Group superficial sediments have a low palaeontological sensitivity.

10.1.3 Geographical extent of impact

The impact on fossil heritage will be restricted 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**.

10.1.4 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**.

10.1.5 Potential significance of the impact

Should the project progress without due care to the possibility of fossils being present at the proposed development site 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**.

10.1.6 Severity / benefit scale

The development will be **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.

10.1.7 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 **low**.

10.1.8 Probability of the impact occurring

Since the Palaeontological Sensitivity ranges from zero to low the probability of significant impacts on palaeontological heritage during the construction phase are **low**.

10.1.9 Damage mitigation, reversal and potential irreversible loss

Mitigation

If fossil material exists within the proposed development any negative or detrimental impact upon it could be mitigated by describing and collecting well-preserved fossils by a palaeontologist. These actions should take place after vegetation clearance 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. If an excavation is impossible or inappropriate, the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.

10.1.10 Degree to which the impact can be mitigated

Recommended mitigation of the damage and destruction of fossil heritage within the proposed footprint would comprise the collection and describing of fossils by a professional palaeontologist. These actions would take place after initial vegetation clearance but *before* the ground is levelled for construction.

10.1.11 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.

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

Stratigraphic and geographical distribution of fossils in the metamorphic basement rocks and the superficial sediments Kalahari Group is expected to be of low palaeontological sensitivity.

Table 1: Impact table of the construction phase of the Groenheuwel Solar Plant

<p>Nature: The excavations and clearing of vegetation during the construction phase of the Groenheuwel Solar plant and associated infrastructure will consist of digging into the superficial sediment cover and possibly the underlying deeper bedrock. These excavations will change the existing topography and</p>

<p>may possibly destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.</p> <p>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.</p>		
	Without mitigation	With mitigation
Extent	Local (1)	Local (1)
Duration	Long term/permanent (5)	Long term/permanent (5)
Magnitude	Moderate (6)	Minor (2)
Probability	Improbable (2)	Very Improbable (1)
Significance	LOW (24)	LOW (20)
Status (positive or negative)	Negative	Neutral
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	Yes
<p>Mitigation procedure</p> <ul style="list-style-type: none"> • 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 EO. The EO must report the find to the relevant Authorities and a relevant palaeontologist. • The developer/contractor must appoint a relevant palaeontologist to investigate and access the chance find and site. • The 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. <p>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</p>		
<p>Residual Risk: Loss of Fossil Heritage</p>		

10.2 Summary of Impact Tables

The development footprint is underlain by the ancient Precambrian granite -gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province as well as the overlying Gordonia Formation of the Kalahari Group. The Palaeontological Sensitivity of the

Kalahari Formation is rated as Low, while that of the Namaqua-Natal Metamorphic Province is zero. 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**. Impacts on palaeontological heritage during the construction phase could potentially occur but are regarded as having a low possibility.

11 FINDINGS AND RECOMMENDATIONS

The proposed development is underlain by the ancient Precambrian granite -gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province as well as the overlying Gordonia Formation of the Kalahari Group. According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Kalahari Group is low and the ancient Precambrian granite -gneisses of the Riemvasmaak Gneiss and Augrabies Granite Gneiss of the Namaqua-Natal Province is zero.

It is therefore considered that the construction and operation of the Groenheuwel Solar Plant, in the Northern Cape is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

In the event that fossil remains are discovered during any phase of construction, either on the surface or exposed by fresh excavations the **Chance Find Protocol** must be implemented by the EO in charge of these developments. These discoveries ought to be secured (preferably *in situ*) and the EO ought to alert SAHRA so that appropriate mitigation (*e.g.* documented and collection) can be undertaken by a professional palaeontologist.

The specialist would need a collection permit from SAHRA. Fossil material must be curated in an approved collection (museum or university) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

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Appendix A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist
YEARS' EXPERIENCE: 26 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 *Daptocephalus 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

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment for the proposed upgrade of existing water supply infrastructure at Noupoort, Northern Cape Province. 2014. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed consolidation, re-division and development of 250 serviced erven in Nieu-Bethesda, Camdeboo local municipality, Eastern Cape. Bloemfontein.

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INTERNATIONAL VISITS

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