BANZAI ENVIRONMENTAL

PALAEONTOLOGICAL DESKTOP ASSESSMENT

10738 – SERE SOLAR PHOTOVOLTIAC PLANT PHASE 1A AND ASSOCIATED INFRASTRUCTURE

WESTERN CAPE PROVINCE

2022

COMPILED FOR

NEMAI CONSULTING

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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SIGNATURE: 

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

Table 1 - NEMA Table

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vitae	Section 2 – refer to Appendix A	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 8	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Desktop Assessment	
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 6 Approach and Methodology	-
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated	Section 1 and 9	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
structures and infrastructure, inclusive of a site plan identifying site alternatives;		
(g) An identification of any areas to be avoided, including buffers	Section 5 No buffers or areas of sensitivity identified	
(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	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6.1 – Assumptions and Limitation	-
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 1 and 9	
(k) Any mitigation measures for inclusion in the EMPr	Section 1	
(l) Any conditions for inclusion in the environmental authorisation	Section 10	Desktop Study
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 10	Desktop Study
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 10	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities or portions	Section 1 and 10	-

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan		
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process will be conducted as part of the EIA and EMPr process.
(p) A summary and copies if any comments that were received during any consultation process	N/A	
(q) Any other information requested by the competent authority.	N/A	.
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Nemai Consulting (Pty) Ltd to conduct the Palaeontological Desktop Assessment to assess the proposed SERE Solar Photovoltaic Plant Phase 1A and associated infrastructure in the Western Cape Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to verify if fossil material could potentially be present in the planned development and the impact thereof on fossils Heritage.

The proposed Sere PV Plant is underlain by the Cenozoic deposits of the West Coast Group that mantles the bedrock of the Gariep Supergroup. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) database the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website).

Two Layout alternatives for the proposed Sere Photovoltaic Plant have been proposed. All alternatives are underlain by the West Coast Group. The geology of the proposed site alternatives is the same and thus no preferences on the grounds of palaeontological fossil heritage, for any specific alternative layout under consideration was identified. The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website). However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that bedrock occurs between 14 m and at a depth greater than 102m. The depth of the sand in the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. **It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.**

It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

However, if any fossil remains or trace fossils are discovered during any phase of construction or operation, either on the surface or exposed by excavations, a **Chance Find Protocol** must be implemented by the ECO in charge of this development. These discoveries should be protected (if possible, *in situ*) and the ECO must report such discovery to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Suitable mitigation (*e.g.* recording and collection) will consequently be undertaken by a palaeontologist.

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

These recommendations should be incorporated into the EMPr for the development.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

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1 INTRODUCTION

1.1 Background and Motivation

The proposed Sere PV facility is situated about 14km west of Koekenaap on the Namaqualand Coast in the Vredendal District, in the Western Cape (Figure 1-7).

Information provided by Nemai

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. To address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity and associated infrastructure:

- Solar PV modules, up to a total of 120,000 m^2, that convert solar radiation directly into electricity. The solar PV modules will be elevated off the ground and will be mounted on either fixed tilt systems or tracking systems. The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between each PV module row. There will be underground cabling connecting Solar PV modules to the Inverter stations.
- Inverter stations, each occupying a footprint up to approximately 30 m^2, with up to 20 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 33kV, to allow the electricity to be fed into the Skaapvlei substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance.
- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations.

- Existing roads that provide access to Sere Wind Farm will be used and extended where necessary (estimated up to 1 km long) to provide access to the PV site.
- A perimeter road around the site, approximately 5 m wide and 1.8 km in length.
    - Internal roads for access to the Inverter stations, approximately 5 m wide and 3.4 km total length.
- Internal roads/paths between the Solar PV module rows, approximately 2.5 m wide, to allow access to the Solar PV modules for operations and maintenance activities.
- Laydown area, occupying a footprint up to 4,000 m^2, located adjacent to the substation. The laydown area will also accommodate water storage tanks (estimated 32 kl for the first 4 months and 20 kl for the remaining 20 months, until construction is completed). This area will also accommodate the offices for construction contractors.
- Batching plant, occupying a footprint up to 7,675 m^2, for the mixing ingredients for concrete.
- The infrastructure required for the operation and maintenance of the Sere PV Plant – Phase 1a installation will be optimized to consider common usage of the existing Sere Wind Farm infrastructure.
- The Solar PV plant facility security cabin, occupying a footprint up to 10 m^2, including ablution facilities.
- Perimeter fencing of the Solar PV site, with access gates. Detailed requirements will be determined following the security risk assessment.
- Construction and installation of underground electrical interconnection cables, with trenching up to 1 km long, connecting the Solar PV facility to the 22-33/132 kV Skaapvlei substation.

Total area of the Solar PV modules will be 16 – 18 ha within the approximate 19.6 ha site

- Proposed PV will be either fixed or tracking PV
    - Fixed or static PV – fixed mounted PV up to 3.5 m above ground level. Fixed or static PV – at 30º, north facing slope
    - Tracking – single or double axis tracking up to 6 m above ground level. Tracking – PV module rows will track the sun path from east to west daily

The foundation of the PV structures will be the main excavation work besides the excavation for the cable connecting the site with the existing substation. Approximate excavation depths are 1.5m.

Eskom confirmed that the batching plant area would be rehabilitated if used by the contractor, but if not used by contractor would be used for extra PV panel installation (of approximately 1.5 MW addition).

Eskom confirmed that the contractors site camp area (0.4 ha) would be used for parking and office buildings for Operation & Maintenance after construction (and would not be rehabilitated).

The solar PV plant has a design life of a minimum of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life.

A Geotechnical report was conducted for the SERE WEF.

BKS Palace Consortium, 2010. Report on the Geotechnical foundation investigation for the proposed Sere Wind Energy at Koekenaap, Western, Cape Province.

Table 2: Stratigraphy of the SERE WEF (Taken from Pether,2020)

Aeolian Deposits of the Cenozoic Era Pale red and orange, very loose to loose, sand. No gravel
Marine Deposits of the Cenozoic Era Lighter coloured, brown and beige, sand, silt, gravel and boulders. Significantly denser than the aeolian deposits above.
Bedrock Phylite, sandstone and quartzitic sandstone of the Gariep Supergroup.

This detailed geotechnical report found sandstone and quartzitic sandstone as well as phylite, of the Gariep Supergroup present at a depth of between 14m and at a depth greater than 102m (see report for detail). The thickness of the Cenozoic deposits varies but test drilling (in proximity of the PV development) found sand at a depth of up to 20 m. The approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.

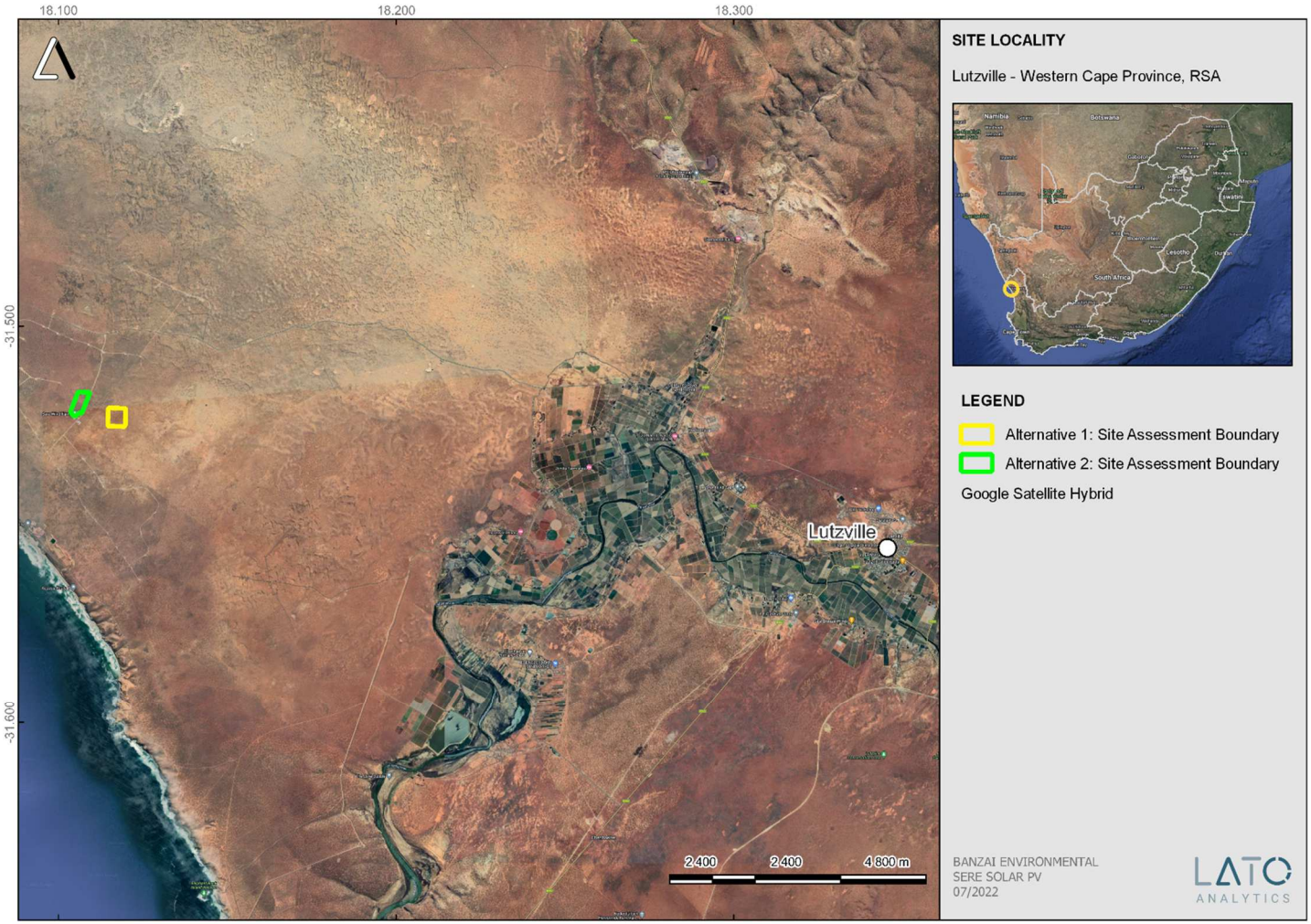


Figure 1:*Regional site locality*

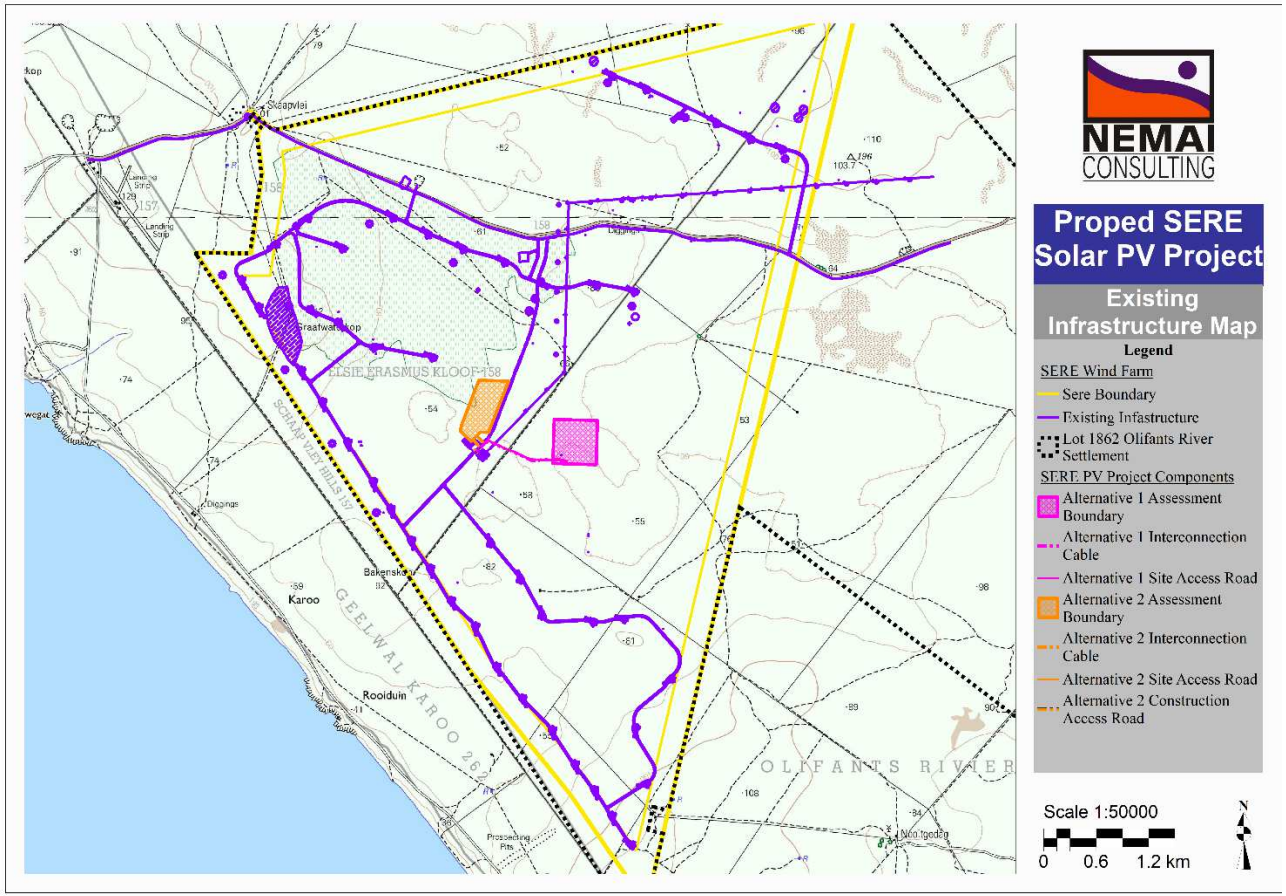


Figure 2: *Proposed Sere PV site in relation to the Sere Wind Farm Facility*

1.2 Alternatives to be considered

1.2.1 Alternative 1 (see Figure 4 below)

- Sere PV Fixed Technology Layout with buildings in the south of the site.
- Sere PV Tracking Technology Layout with buildings in the south of the site.
- Access Road that connects to the south of the site.
- Interconnection electrical cable that connects to the south of the site.

Figure 3: Alternative 1 - Fixed and Tracking layouts within the Assessment Site Boundary (yellow) showing cable and access road routes.

1.2.2 Alternative 2 (see Figure 5 below)

An alternative site has been proposed to the west of the original site (Alternative 1)

- Access roads connecting to the existing access road to the east
- Cable route between the site and the substation will follow the exiting road as close as possible
- The excavation for the cable route will be 1 m wide (and 1m deep), with an estimated 10 m working servitude

Figure 4: Alternative 2 - Fixed and Tracking layouts within the Assessment Site Boundary showing Alternative cable and road routes.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and

Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

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".

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

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

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

GNR 982 (Government Gazette 38282, 14 December 2014, amended 2017) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

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

National Heritage Resources Act (NHRA) Act 25 of 1999

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

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

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

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

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m² in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The aim of a Palaeontological Impact Assessment (PIA) is to decrease the effect of the development on potential fossils at the development site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the purpose of the PIA is: 1) to identify the palaeontological importance of the rock formations in the footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) to clarify the impact on fossil heritage; and 4) to suggest how the developer might protect and lessen possible damage to fossil heritage.

The palaeontological status of each rock section is calculated as well as the possible impact of the development on fossil heritage by a) the palaeontological importance of the rocks, b) the type of development and c) the quantity of bedrock removed.

When the development footprint has a moderate to high palaeontological sensitivity a field-based assessment is necessary. The desktop and the field survey of the exposed rock determine the impact significance of the planned development and recommendations for further studies or mitigation are made. Destructive impacts on palaeontological heritage usually only occur during the construction phase while the excavations will change the current topography and destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation usually precede construction or may occur during construction when potentially fossiliferous bedrock is exposed. Mitigation comprises the collection and recording of fossils. Preceding excavation of any fossils a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied correctly, a positive impact as possible because our knowledge of local palaeontological heritage may be increased.

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/kml's) 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 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 PALAEONTOLOGICAL HISTORY

The geology of the SERE Solar Photovoltaic Plant in the Western Cape Province is depicted on the 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria) (Figure 6, Table 3) with a short sheet explanation by Theron *et al.* (1991). According to this map the proposed Sere PV Plant is underlain by superficial Cenozoic deposits (Ç – s, red dune sand). Recent Shape files compiled by the Council of Geosciences (Pretoria) indicates that the proposed SERE development is underlain by the West Coast Group (Figure 7-9). The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Figure 10) (Almond and Pether 2008, SAHRIS website).

As previously stated in this report the excavations for the PV development will only be approximately 1.5m deep and these excavations will only penetrate into the aeolian sands. The West Coast Group is in depth underlain by various bedrock types that is not of palaeontological interest. North of the proposed development superficial sediments is underlain by basement gneisses of the Namaqua Metamorphic Province that are older than 1000 million years. These basement rocks include the Gifberg Metasediments, Table Mountain Group sandstones as well as intrusions comprising of dykes, pipes, and plutons.

The West Coast Group comprises of Cenozoic coastal deposits located between the Orange River and Elandsbaai (Roberts *et al*., 2006). The early coastal plane was flooded by the sea during the late Cretaceous. Nowadays the marine record of the palaeo-shorelines are uplifted to 150 to 2000asl. These older portions of the coastal plain are kaolinized (white china clay) and deeply weathered and mantled by silcrete in places. The latter developed in poorly drained low areas in tropical, stages of humid weathering during the latest Cretaceous and earlier Cenozoic. The deep weathering and formation of silcrete formed from tropical weathering in humid times during the latest Cretaceous or earlier Cenozoic.

Ancient river channels (representing wetter climates during the early Cenozoic) are buried between the major Namaqualand rivers. During the early Cenozoic more rivers drained the coastal plane. These channels infill have also been kaolinized while silcrete formed in places within the upper channels (the so-called Channel-clays) now known as the Koingnaas Formation (De Beer, 2010). The outcrops around the development are formed by the sands and white, kaolinitic quartz gravels of the Koingnaas Formation. These exposures are the best-preserved natural exposures of the Koingnaas Formation in Namaqualand. This Formation is mantled by younger deposits.

Plant fossils occur in carbonaceous beds of peaty material, while fossilized wood of the tropical African mahogany has been found. Silicified, fossil wood has been uncovered in the gravels of the Olifants Rivier (near Vredendal) and was presumably reworked from the Koingnaas Formation. Fossil pollen represents numerous trees (including yellowwood forests, conifers, and ironwoods).

The aeolian coversands of the Namaqualand coastal plain comprises of extensive marine formations containing warm-water mollusc assemblages. Currently these formations are formally divided in the Alexander Bay Formation comprising of the Kleinzee, Avontuur and Hondeklipbaai Members. But each of these marine formations occupy a detailed spatial position in the stratigraphic geometry, is characterized by different faunas of different ages and are worthy of full formation status (Pether, 2018). The Quaternary Curlew Strand Formation is close to the coast and includes three "raised beaches" comprising of modern cold-water fauna. The Alexander Bay Formation is thus endorsed to Subgroup and includes all four marine formations (Pether, 2018).

The SERE Solar PV development footprint is located on the outer margin of the coastal plain and the formations that could be impacted are the marine and younger aeolian formations. Extensive research has been conducted on deposits of the West Coast Group and includes papers by Carrington & Kensley, 1969; Kensley & Pether, 1986, De Beer et al. (2002), Elferink (2005).

Kleinzee Formation (90m Package)

The Kleinzee Formation (Mid-Miocene Climatic Optimum) is the oldest marine formation located on the inner high part of the coastal bevel/cliff extending seawards from about 90m asl (above sea level) or commonly known as the 90m Package. This Formation was deposited about 17 to 15 Ma ago when the high sea level of the warm Mid-Miocene Climatic Optimum dropped. Miocene marine beds weathered when the sea-level rose during the Early Pliocene Warm Period. A hominoid tooth as well as petrified teeth of extinct pigs were described from the basal gravels of this Formation (18 - 17.5 Ma) (Pickford & Senut, 1997). These fossils were reworked from earlier terrestrial deposits. The Kleinzee Formation has a rare shelly fauna that is poorly preserved and relatively unstudied. The zone fossil for this formation is the thick-shelled bivalve *Isognomon gariesensis*

Avontuur Formation (50m Package)

The Avontuur Formation (50m Package) represents the Early Pliocene Warm Period and was deposited as the sea-level retreated from the transgression high of almost 50m asl and the shoreline advanced seawards (about 5-4 Mya). The Avontuur Formation was also eroded by a rising in sea-level about ~3 Mya during the Mid-Pliocene Warm Period. Fossils of the Avontuur Formation is generally decalcified, fairly well preserved and thus fairly well sampled (Carrington & Kensley, 1969; Kensley & Pether, 1986). The zone fossil is the extinct *Donax haughtoni* "surf clam". This Formation also contains petrified wood as well as reworked vertebrate remains from older periods. The latter includes the teeth and bones of extinct proboscideans, bovids and equids, rhinocerotids, shark

teeth, as well as whales. The bear-dog *Agnotherium* sp. (13 - 12 Ma) and gomphothere *Tetralophodon* (12 - 9 Ma), represents the oldest fossils in the basal assemblage but the general age of fossils in this formation is late Miocene (7.5 - 5 Ma). Important finds in this formation include the suid (bushpig) *Nyanzachoerus kanamensis* and phocid (seal) *Homiphoca capensis*. These fossils are contemporaneous with the Pliocene Varswater Formation uncovered at the West Coast Fossil Park near Saldanha.

Hondeklipbaai Formation (30 m Package)

The 30 m Package (Hondeklipbaai Formation) represents the Mid-Pliocene Warm Period and accumulated as the sea-level dropped from a high of about 30-33 m asl while the marine formation extended seawards (Pether, 1994; Pether, in Roberts et al., 2006). This Formation could extend up to a few km in width. The marine formations of the Miocene and Pliocene contain fossil shells of warm water species as well as extinct shell species that characterise the Formation. This formation is the last major formation of the coastal plane and was deposited during a very high sea level that has never since been surpassed. Molluscs lived and thrived in the warm waters, and it is difficult to postdate the commencement of the major cooling of the Benguela System. Core samples taken from Lüderitz indicates that the diatom microfossil assemblages extend from 4.5 Ma. The water temperatures declined from about 3Ma ago with a previous high of about 26° during the late Pliocene (Marlow et al., 2000).

This 30m Package is probably older than 3 Ma and corresponds to the "Mid-Pliocene Warm Period" where the Pliocene sea-level was high (about 3.0 to 3.4 Ma). This Formation consists of coarse-sand and is extensively decalcified and reddened. At present fossils shell of this formation is rare and the collection needs to be expanded. Early fossil collection was conducted by Haughton (1926, 1928, 1932) and are kept in the IZIKO Collections . As in most cases the collection date was neglected and most of these specimens lack precise locations. Fossil collection in this Formation was bias towards robust shells . The zone fossil is the large extinct "surf clam" *Donax Rogers*'.

Curlew Strand Formation

The Curlew Strand Formation consists of the amalgamation of old beaches comparable to the Velddrif Formation of the SW Cape Coast. This Formation consist of an 8 - 12 m Package that is about 400 ka years old (ka = thousand years ago), the 4 - 6 m Package of the Last Interglacial (~125 ka) and the 2 - 3 m Package (6-4 ka, mid-Holocene High).

Fossils of this formation are mostly resent cold-water fauna. Extended erosion of the older marine deposits has taken place, mostly by wind deflation decalcification, pedogenic reddening and the formation of pedocretes beneath palaeosurfaces. The eroded marine sequences are overlain by various terrestrial deposits. These deposits are mostly extensive aeolian dune and sandsheet deposits. Pether (2018) conducted the PIA for the Tormin mine extension just west of the proposed development. He recognized aeolian formations of later Miocene, mid-Pliocene, late Pliocene, and several Quaternary ages.

Quaternary raised beaches is present more north of the development where bedrock with low gradients occurs inland. Fossils in the Quaternary Curlew Strand Formation is rare but may comprise of marine animals and sea birds. These specimens may be closely related to modern marine species, but unexpected, rare fossils may occur and would be of scientific value.

Older Aeolianite Formations

The Terrestrial record

Various terrestrial deposits are also present in the coastal plain of Namaqualand. These deposits are mostly aeolian dune and sandsheet deposits that overlie the weathered tops of the marine formations. Locally these deposits may be ephemeral stream channel and colluvial (sheetwash) deposits linked with hillslopes and are sometimes interbedded with aeolian deposits. In the upper parts of the terrestrial and marine sequences a variety of palaeosols and pedocretes is present with different compositions and degrees of development. These sediment have not yet been stratigraphically formalized, and formations are only generally defined.

The Aeolianite formations is inadequately studied and comprise of the following formations.
The Graauw Duinen Formation is aeolianites of Pliocene age. This Formation is a thick aeolianite accumulation in the south of the West Coast. Fossilized eggshells of the extinct Pliocene giant ostrich, Struthio daberasensis (Roberts, in Roberts et al., 2006), skeletal remains of the bovid *Numidocapra crassicornis*, and teeth of the extinct sabre-toothed felid, *Dinofelis barlow*. have been recorded. The Dorbank Formation varies in thickness and is a large, compact red-brown unit.

Younger Aeolianite Formations

The younger aeolianite formations are pale-hued in colour and comprise of relatively-soft aeolianite units. The coastal units of this formations comprise of the following

- Koekenaap Formation overlies the Dorbank Formation, compact but unconsolidated red sands, widely distributed in Namaqualand (Roberts et al., 2006; De Beer, 2010). These sands occupy large areas of the Namaqualand coastal plain
- The Hardevlei Formation occurs mostly inland and comprise of pale-yellow dunes with a complex, reticulate morphology
- *Swartlintjies and Swartduine Formations* is large, semi-stabilized, pale plumes of, parabolic dune Ridges. The latter expands from the beaches north of the major rivers (Roberts *et al*., 2006; De Beer, 2010). The Swartduine Formation is present in interdune areas between the Swartlintjies Formation and comprise of grey sandsheet as well as small dunes with smooth vegetation.
- The Witzand Formation comprise of sand and shell fragments. Originated in the Holocene and has blown from sandy beaches. This formation is located northward from the Sandveld Group of the southwestern Cape

Fossils from the Aeolian Formations

Fossils in the aeolian sands are extremely rare and usually found in sand dunes. These fossils include tortoise shells, mole bones as well as land snails. Rarer fossils consist of small mammal and bird bones. Fossils are more abundantly found in palaeosurfaces and their soils that formed when dunes stabilized. Larger fossil bones are more commonly found along palaeosurfaces overlying marine deposits as well as palaeosurfaces between main aeolianite units. Dune slopes along the coast usually contain more fossils as it is utilized for foraging and scavenging. Jackals and hyaenas carry they prey to sand slopes and bones are collected around hyaena dens. These dens are often found on sea-facing aeolianite slopes. Fossils are noticed when bones is exposed to the surface and are falling downslope. These rare fossils find are important as they are important in biostratigraphic, palaeobiological and palaeoclimatic research.

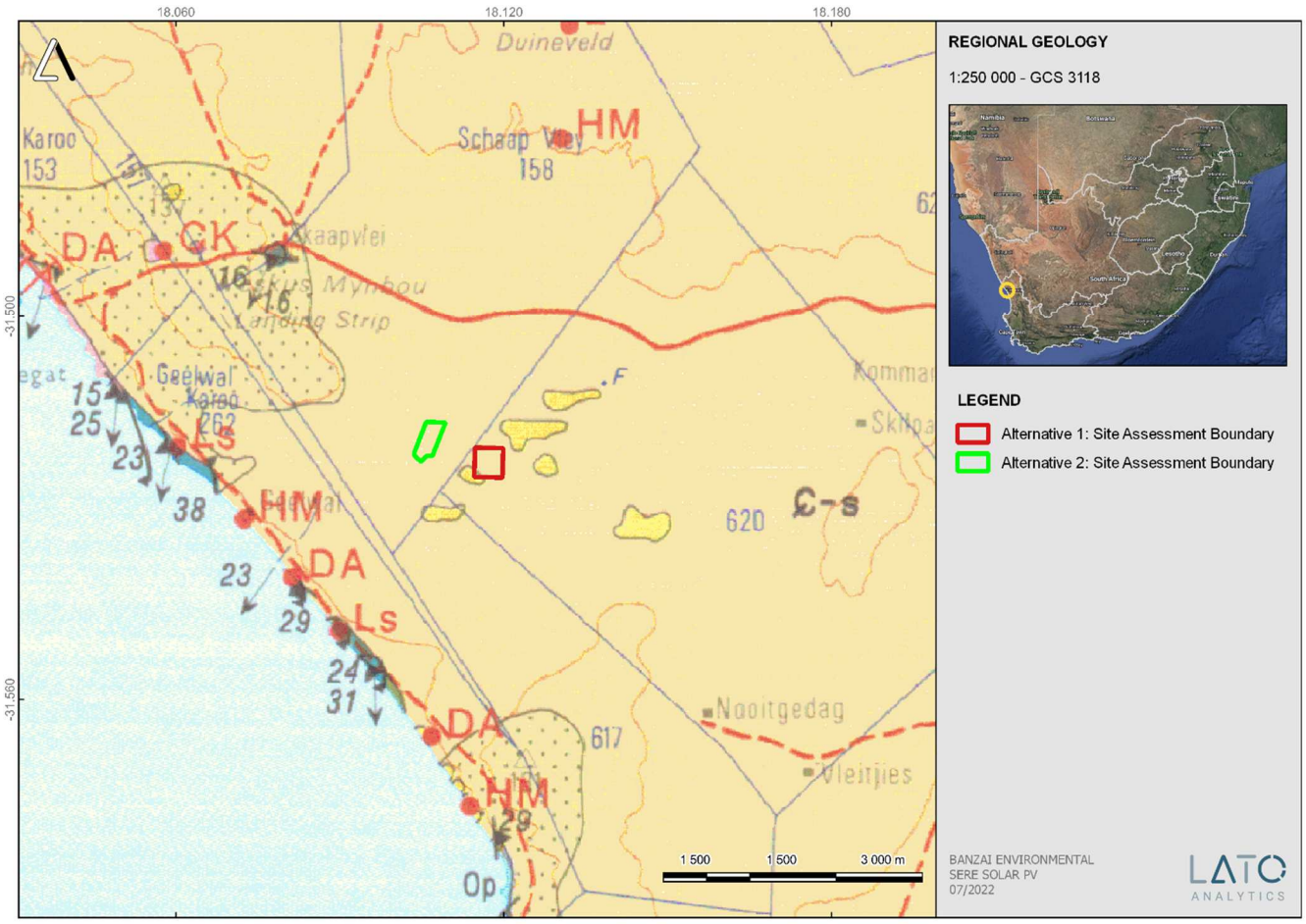
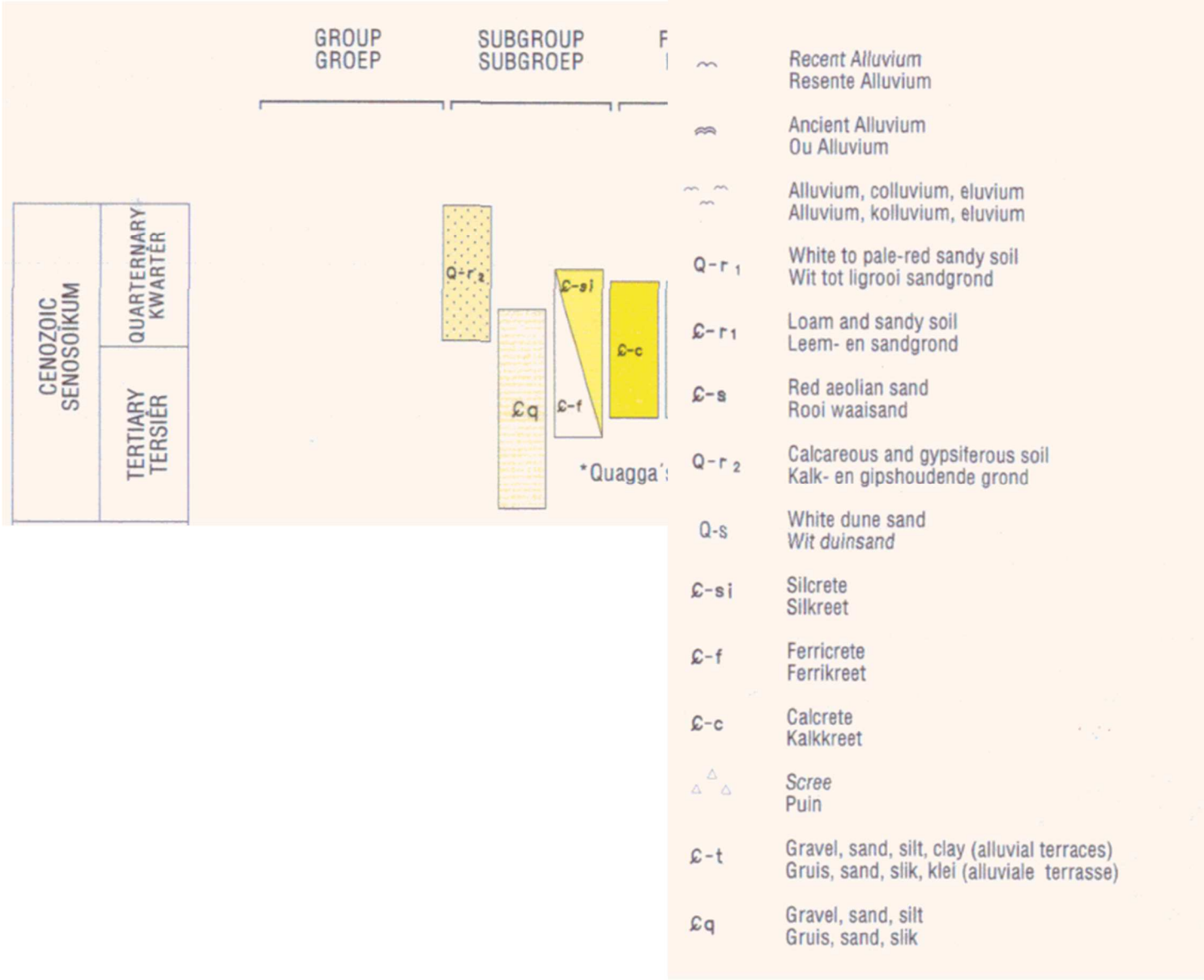


Figure 5: Extract of the 1: 250 000 Calvinia 3118 Geological Map (Council of Geosciences, Pretoria) indicates that the proposed SERE PV and associated infrastructure is underlain by sediments of the West Coast Group.

Table 3:Legend of the 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria)



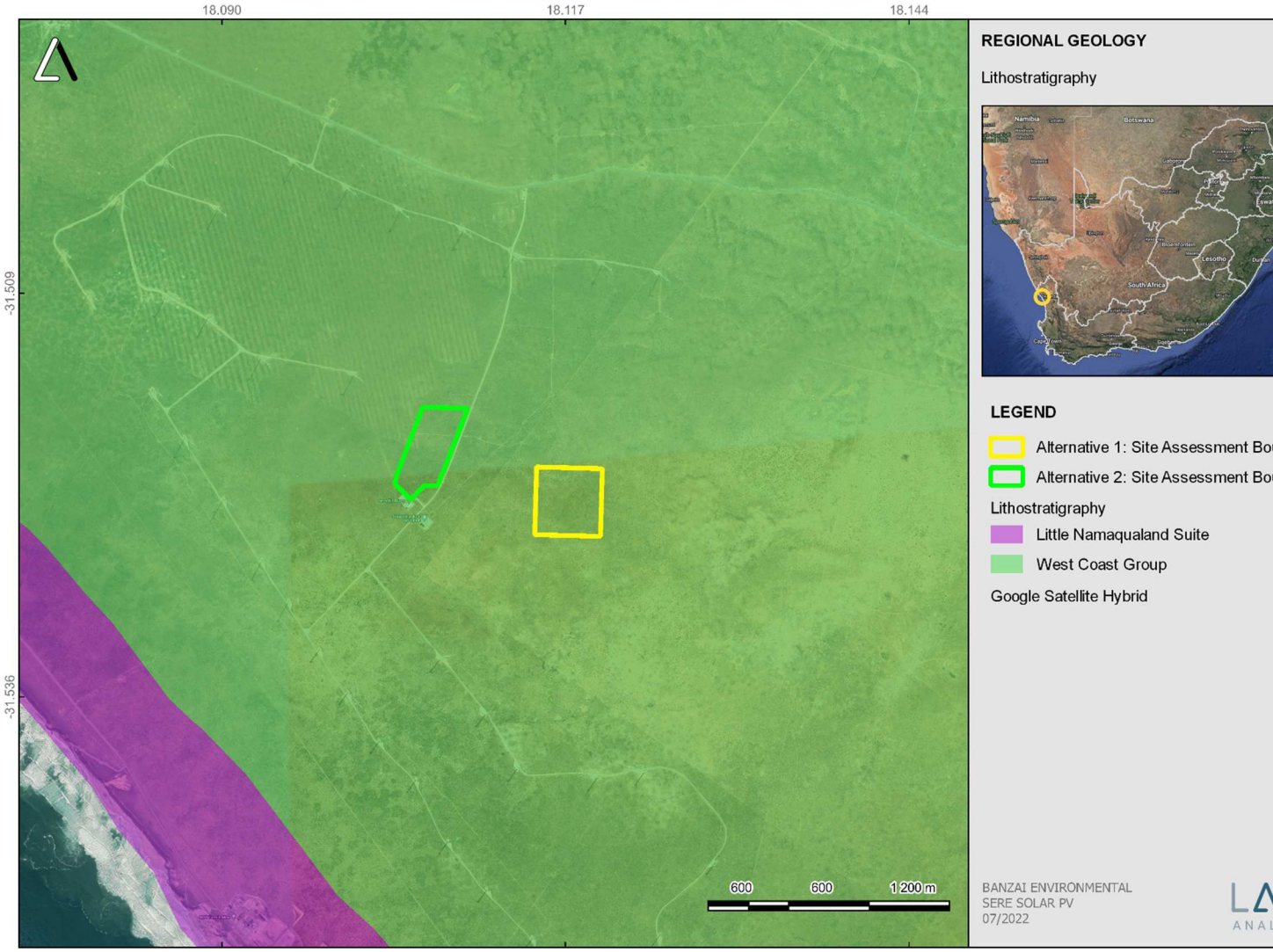


Figure 6:Regional Geology indicated by Shape Files produced by the Council of Geosciences, Pretoria.

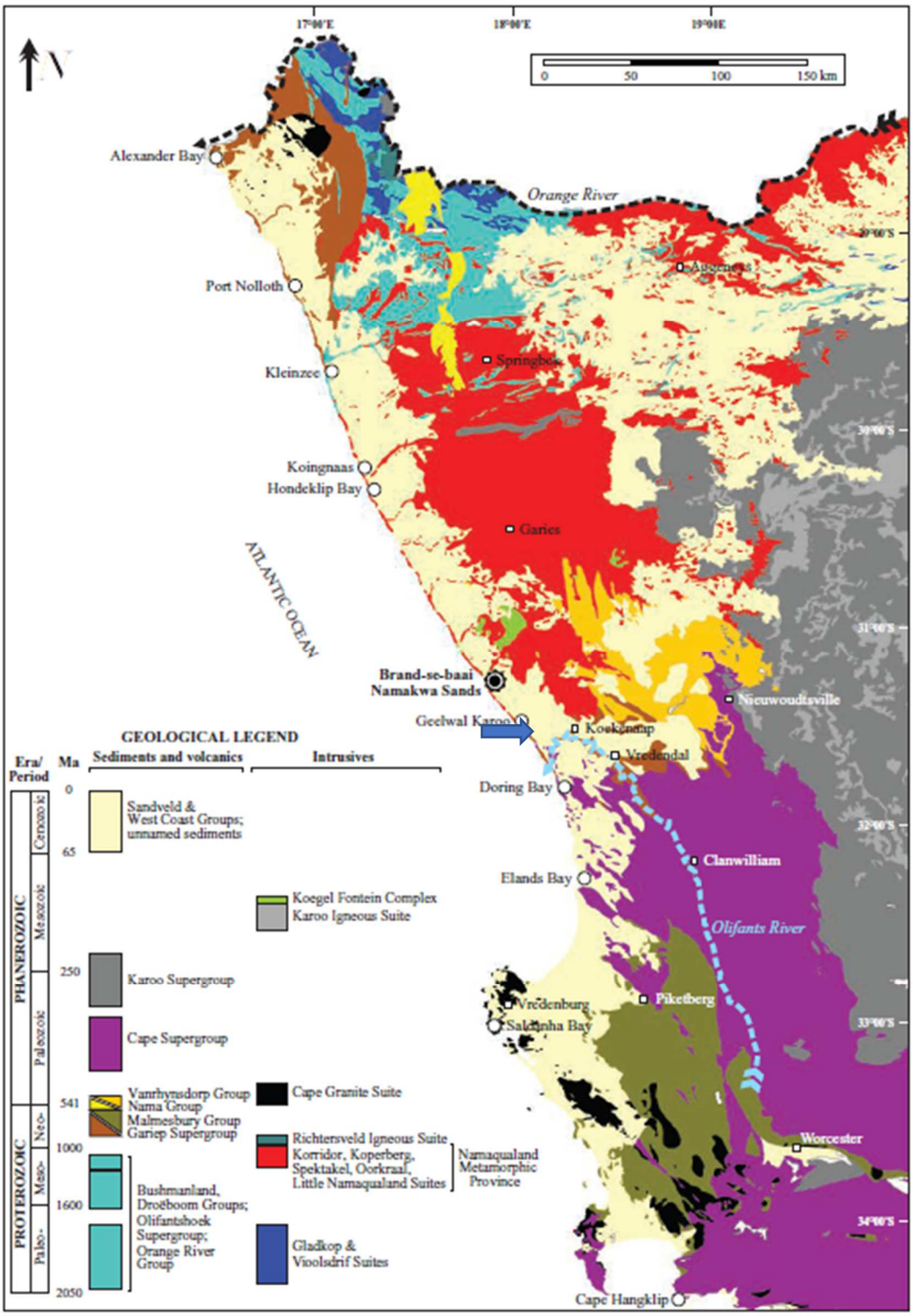


Figure 7: Simplified geology and stratigraphy of the western portion of South Africa (Council of Geosciences unpublished data). Proposed development it indicated in a blue arrow. Image from (Philander en Rosendaal ,2015)

Table 4: Stratigraphy of the Cenozoic West Coast Group (after De Beer, 2010)

Age		Era/Period/Epoch		Sedimentary deposits
11.5 ka	CENOZOIC	QUATERNARY	Holocene	Witzand Formation Swartduine Formation°
1.8 Ma			Pleistocene	Swartlintjies Formation° Hardevlei Formation Curlew Strand Formation° Koekenaap Formation Panvlei Formation°
24 Ma		NEOGENE	Pliocene	Graauw Duinen Formation° Alexander Bay Formation Hondeklip Bay Member° (30m Package) Avontuur Member° (50m Package)
			Miocene	Kleinsee Member° (90m Package)
65 Ma		PALEOGENE	Oligocene	Koingnaas Formation° De Toren Formation°

Note: ° = not approved by the South African Committee for Stratigraphy (SACS)

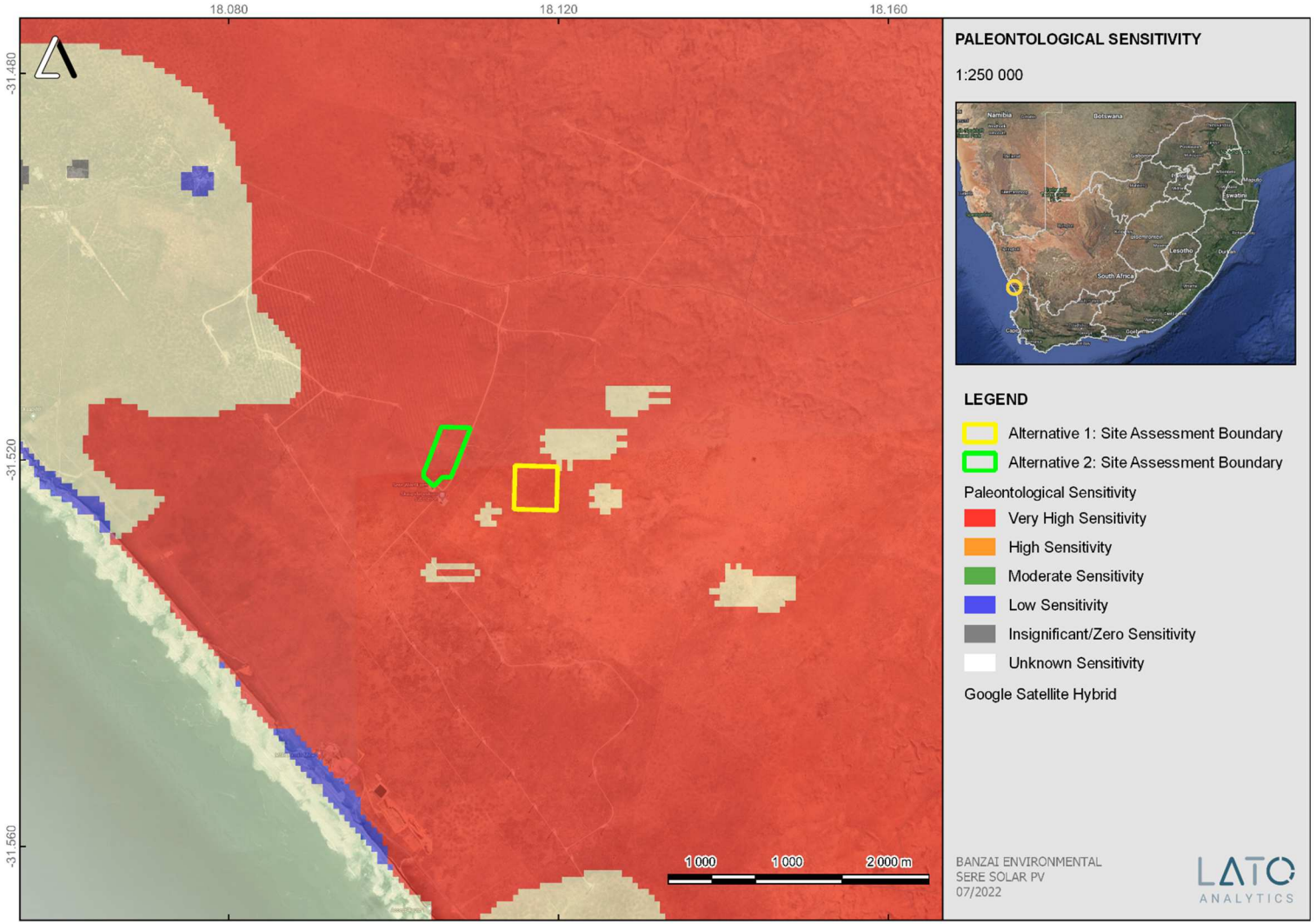


Figure 8: Extract of the 1:250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the proposed development.

Table 5: Palaeontological Significance

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.

The colours on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero

According to the SAHRIS Palaeosensitivity map (**Figure 10)** the proposed development is underlain by sediments of Very High (red) Palaeontological Sensitivity. However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that the sand depth of the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. **It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project and that the Palaeontological Significance of the proposed development will thus be LOW.**

6 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile a desktop study and includes Palaeontological impact assessment reports in the same area, aerial photos, and Google Earth images, topographical as well as geological maps.

6.1 Assumptions and Limitations

When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally assumed that exposed fossil heritage is present within the footprint.

7 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).
- 1: 250 000 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria). Calvinia Area, Sheet explanation: Sheet 3118 Calvinia, 1:250 000 scale, The Council for Geoscience, Geological Survey of South Africa)
- A Google Earth map with polygons of the proposed development was obtained from Bokomaso Landscape Architects & Environmental Consultants CC.
- *Geotechnical Report conducted for the SERE WEF (BKS Palace Consortium, 2010)*

8 IMPACT ASSESSMENT METHODOLOGY

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

- Construction;
- Operation; and
- Decommissioning.

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

Only one Impact Assessment is included in this report as the geology of the two alternatives is the same and thus impacts on the two alternatives will be the same.

Specific values allocated to each impact is indicated in yellow

Table 6: The rating system

NATURE		
The Nature of the Impact is the possible destruction of fossil heritage		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		

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

1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.

IRREPLACEABLE LOSS OF RESOURCES
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.

1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.

CUMULATIVE EFFECT

This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.

1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula:

(Extent (1) + probability (1) + reversibility (4) + irreplaceability (4) + duration (4) + cumulative effect(2)) x magnitude/intensity (1)= 16.

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.

29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive

8.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, 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 probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

Table 7: Summary of Impacts

	Site	Probability	Duration	Magnitude	Reversibility	Irreplicable Loss	Cumulative Effect	Significance	Significance
Pre-mitigation	1	1	4	4	4	4	2	64	Negative high Impact
Post-mitigation	1	1	1	1	1	1	2	16	Negative low Impact

9 FINDINGS AND RECOMMENDATIONS

The proposed Sere PV Plant is underlain by **West Coast Group**. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) database the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website).

Two Layout alternatives for the proposed Sere Photovoltaic Plant have been proposed. All alternatives are underlain by the West Coast Group. The geology of the proposed site alternatives is the same and thus no preferences on the grounds of palaeontological fossil heritage, for any specific alternative layout under consideration was identified. The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website). However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that the sand depth of the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.

It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may

be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

However, if any fossil remains or trace fossils are discovered during any phase of construction or operation, either on the surface or exposed by excavations, a Chance Find Protocol must be implemented by the ECO in charge of this development. These discoveries should be protected (if possible, *in situ*) and the ECO must report such discovery to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Suitable mitigation (*e.g.* recording and collection) will consequently be undertaken by a palaeontologist.

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

These recommendations should be incorporated into the EMPr for the development.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

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10 CHANCE FINDS PROTOCOL

The following procedure will only need to be followed if fossils are uncovered during excavation. This informational document is intended for workmen and foremen on the construction site. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

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

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

10.2 Protocol

- If a chance find is made the person responsible for the find must immediately stop working and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately report the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within 24 hours of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.

- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. No attempt should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (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 Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix A: CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 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

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	National Museum, Bloemfontein
and Collection Manager	1998–currently

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.

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

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Butler, E. 2015. Palaeontological Impact Assessment of the proposed township establishment on the remainder of portion 6 and 7 of the farm Sunnyside 2620, Bloemfontein, Mangaung metropolitan municipality, Free State, Bloemfontein.

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Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City of Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Heidedal filling station on Erf 16603, Heidedal Extension 24, Mangaung Local Municipality, Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Savannah South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

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Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's River valley Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape Province. Savannah South Africa. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a Photovoltaic Solar Power station near Collett substation, Middelburg, Eastern Cape. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvior aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. PIA site visit and report of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of Tina Falls Hydropower and associated power lines near Cumbu, Mthlontlo Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of the Mangaung Gariep Water Augmentation Project. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of a railway siding on a Portion of portion 41 of the farm Rustfontein 109 is, Govan Mbeki local municipality, Gert Sibande district municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed extension of the Kareerand Tailings Storage Facility, associated borrow pits as well as a storm water drainage channel in the Vaal River near Stilfontein, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of a filling station and associated facilities on the Erf 6279, district municipality of John Taolo Gaetsewe District, Ga-Segonyana Local Municipality Northern Cape. Bloemfontein.

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Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Overvaal Trust PV Facility, Buffelspoort, North West Province. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Rustplaas near Piet Retief, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed development of the new Mutsho coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commissioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological field Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed Mookodi – Mahikeng 400kV line, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Thornhill Housing Project, Ndlambe Municipality, Port Alfred, Eastern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328. Bloemfontein.

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Butler, E. 2018 Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment of the proposed Megamor Extension, East London. Bloemfontein

Butler, E. 2018. Palaeontological Impact Assessment of the proposed diamonds Alluvial & Diamonds General Prospecting Right Application near Christiana on the Remaining Extent of Portion 1 of the Farm Kaffraria 314, Registration Division HO, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of a new 11kV (1.3km) Power Line to supply electricity to a cell tower on farm 215 near Delportshoop in the Northern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment of the proposed construction of a new 22 kV single wood pole structure power line to the proposed MTN tower, near Britstown, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological Exemption Letter for the proposed reclamation and reprocessing of the City Deep Dumps in Johannesburg, Gauteng Province. Bloemfontein.

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Butler, E. 2018. Proposed Kalabasfontein Mine Extension project, near Bethal, Govan Mbeki District Municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Mookodi – Mahikeng 400kV Line, North West Province. Bloemfontein.

Butler, E. 2018. Environmental Impact Assessment (EIA) for the Proposed 325mw Rondekop Wind Energy Facility between Matjiesfontein and Sutherland in the Northern Cape Province.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of the Tooverberg Wind Energy Facility, and associated grid connection near Touws River in the Western Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological impact assessment of the proposed Kalabasfontein Mining Right Application, near Bethal, Mpumalanga.

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Butler, E., 2019. Palaeontological Field Assessment for the proposed Sirius 4 Photovoltaic Solar Energy Facility near Upington, Northern Cape Province

Butler, E., 2019. Palaeontological Field Assessment for Heuningspruit PV 1 Solar Energy Facility near Koppies, Ngwathe Local Municipality, Free State Province.

Butler, E., 2019. Palaeontological Field Assessment for the Moeding Solar Grid Connection, North West Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological studies for the Proposed Agricultural Development on Farms 1763, 2372 And 2363, Kakamas South Settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

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Butler, E., **2019.** Palaeontological Desktop Assessment of the proposed updated Environmental Management Programme (EMPr) for the Assmang (Pty) Ltd Black Rock Mining Operations, Hotazel, Northern Cape

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Butler, E., 2019. Recommended Exemption from further Palaeontological studies for the proposed agricultural development on farms 1763, 2372 and 2363, Kakamas South settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological Studies for Proposed formalisation of Gamakor and Noodkamp low-cost Housing Development, Keimoes, Gordonia Rd, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

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Butler, E., 2019. Palaeontological Impact Assessment for the proposed Umsobomvu Solar PV Energy Facilities, Northern and Eastern Cape

Butler, E., 2019. Palaeontological Desktop Assessment for six proposed Black Mountain Mining Prospecting Right Applications, without Bulk Sampling, in the Northern Cape.

Butler, E., 2019. Palaeontological field Assessment of the Filling Station (Rietvlei Extension 6) on the Remaining Portion of Portion 1 of the Farm Witkoppies 393JR east of the Rietvleidam Nature Reserve, City of Tshwane, Gauteng

Butler, E., 2019. Palaeontological Desktop Assessment of The Proposed Upgrade of The Vaal Gamagara Regional Water Supply Scheme: Phase 2 And Groundwater Abstraction

Butler, E., 2019. Palaeontological Desktop Assessment of The Expansion of The Jan Kempdorp Cemetery on Portion 43 Of Farm Guldenskat 36-Hn, Northern Cape Province

Butler, E., 2019. Palaeontological Desktop Assessment of the Proposed Residential Development on Portion 42 Of Farm Geldunskat No 36 In Jan Kempdorp, Phokwane Local Municipality, Northern Cape Province

Butler, E., 2019. Palaeontological Impact Assessment of the proposed new Township Development, Lethabo Park, on Remainder of Farm Roodepan No 70, Erf 17725 And Erf 15089, Roodepan Kimberley, Sol Plaatjies Local Municipality, Frances Baard District Municipality, Northern Cape

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