PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE PROPOSED CONSTRUCTION OF THE 150 MW NOUPOORT CONCENTRATED SOLAR POWER (CSP) FACILITY AND ASSOCIATED INFRASTRUCTURE ON PORTION 1 AND 4 OF THE FARM CAROLUS POORT 167 AND THE REMAINING EXTENT OF FARM 207, NEAR NOUPOORT, NORTHERN CAPE PROVINCE

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EXECUTIVE SUMMARY

CRESCO Energy (Pty) Ltd proposes the development of a Concentrated Solar Power (CSP) facility as well as associated infrastructure on Portion 1 and 4 of the Farm Carolus Poort 167 and the Remaining Extent of Farm 207, situated approximately 4 km North West of Noupoort. The proposed site falls within the jurisdiction of the Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality in the Northern Cape Province. The contracted capacity of the Noupoort CSP Project will be up to 150MW with an approximate development area of 430 ha in extent. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the CSP Facility on the palaeontological resources.

The development footprint is predominantly underlain by the Late Permian to early Triassic Adelaide and Tarkastad Subgroups of the Karoo Supergroup, as well as Early Jurassic Karoo Dolerite (183 ± 2 Ma). The Adelaide and Tarkastad Subgroup biostratigraphic zones include a rich and diverse vertebrate fauna of exceptionally high scientific significance due to their part in recording the evolutionary transition from reptiles to mammals.

The scarcity of fossil heritage and low relief with no steep river gulleys or sharp outcrops at the proposed development footprint indicate that the impact of the Noupoort CSP Project will be of a low significance in palaeontological terms. **It is therefore considered that the construction and operation of the Noupoort CSP Project and associated power line 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 CSP facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

Should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted immediately. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

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

Contents

1 INTRODUCTION

Savannah Environmental (Pty) Ltd has been appointed as the independent Environmental Assessment Practitioners (EAP) by **CRESCO Energy (Pty) Ltd** for the undertaking of the Environmental Impact Assessment process for the proposed Noupoort Concentrated Solar Power (CSP) project. The construction of a CSP solar energy facility as well as associated infrastructure on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207, approximately 4 km north west of Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape province is proposed (Fig. 1).

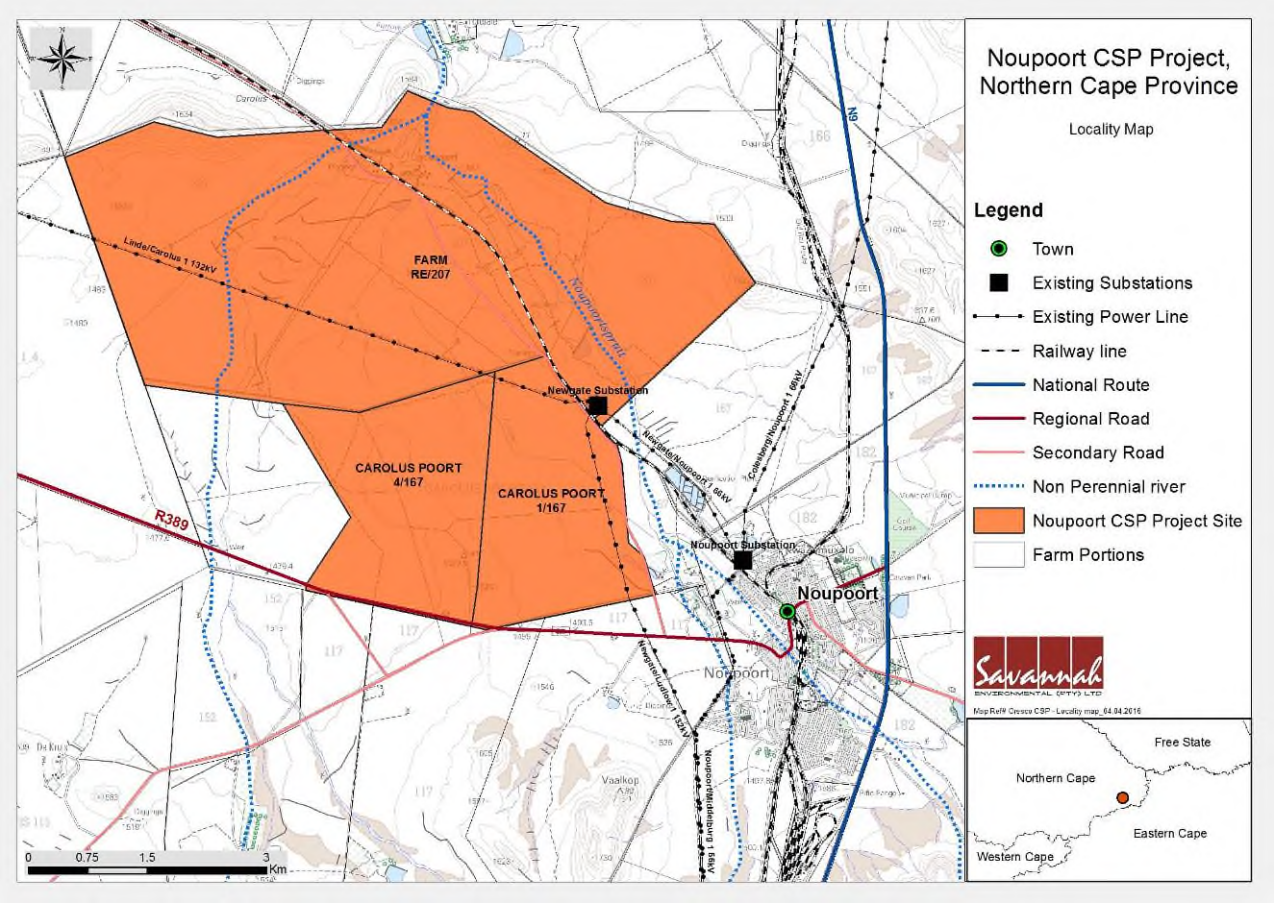

Figure 1. Location of the proposed Noupoort Concentrated Solar Power (CSP) Project (filled in orange) on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207, north west of Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province. (Map provided by Savannah Environmental).

The infrastructure associated with the CSP facility will include: (information was provided by Savannah Environmental)

- Solar collector field consisting of all systems and infrastructure related to the control and operation of the parabolic troughs;
- Energy Centre, including the storage media and heat exchanger;
- Power Block, containing the steam turbine and generator, as well as the air-cooled condenser and associated feed-water system and cooling dams;
- On-site project substation;
- A new 132kV power line to connect the on-site substation to the Eskom's electricity grid;
- Access roads and fencing around the development area;
- Lined evaporation pond;
- Auxiliary boilers for facility start-up/shutdown/maintenance of boiler and steam production stability;
- Water supply pipeline;
- On-site water storage tanks/reservoirs;
- Water treatment facility;
- Waste water treatment facility
- Plant assembly facility;
- Offices and workshop areas for maintenance and storage; and
- Temporary laydown areas.

The trough technology to be utilised for this project is based on a floating field concept. This concept provides above ground installation of parabolic trough sections using a set of rails. Extensive bedrock excavations are not envisaged, but vegetation will need to be trimmed to an acceptable height. The heat transfer media (HTF) is water based, non-toxic and inexpensive and permits operating at high temperature without typical operational problems e.g. freezing.

The facility's grid connection point will be finalised based on input from Eskom and the environmental assessment. Two alternatives are being considered:

- Direct connection to the existing 132kV Newgate Substation (situated directly adjacent to the development area) and
- Direct connection to the 66kV Noupoort Substation (located 3 km south-east of the development area), and the Newgate Substation.

1.1 LEGISLATION

Cultural Heritage in South Africa is governed by the National Heritage Resources Act (Act 25 of 1999). This Palaeontological Scoping Study forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the above mentioned Act. In accordance with Section 38, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 25 OF 1999

The various categories of heritage resources are recognised as part of the National Estate in Section 35 of The National Heritage Resources Act. This include among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

According to Section 35 of the National Heritage Resources Act 1999, dealing with archaeology, palaeontology and meteorites:

- The protection of archaeological and palaeontological sites and material and meteorites are the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
- No person may, without a permit issued by the responsible heritage resources authority—
    - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
    - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
    - trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
    - bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for

a permit has been submitted and no heritage resources management procedure in terms of Section 38 has been followed, it may—

- serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order; and/or
- carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.

2 Objective

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports' the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

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

When a palaeontological desktop/scoping study is conducted, the potentially fossiliferous rocks (i.e. groups, formations, members, etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is collected from published scientific literature; Fossil sensitivity map; consultations with professional colleagues, previous palaeontological impact studies in the same region and the databases of various institutions may be consulted. This data is then used to assess the palaeontological sensitivity of each rock unit of the study area on a desktop level. The likely impact of the proposed development on local fossil heritage is subsequently established on the basis of

- the palaeontological sensitivity of the rocks and
- the nature and scale of the development itself (extent of new bedrock excavated).

When rocks of moderate to high palaeontological sensitivity are present within the study area, a field-based assessment by a professional palaeontologist is necessary. Based on this desktop data as well as a field examination of representative exposures of all major sedimentary rock present, the impact significance of the planned development is considered with recommendations for any further studies or mitigation.

3 BACKGROUND TO THE GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods. During this period the basin developed from an inland sea flooded by a melting ice cap, to a giant lake (Ecca Lake) fed by seasonal meandering (and periodically braided) rivers. The lake progressively shrank as it filled with sediment and the basin's rate of subsidence stabilised.

The Beaufort group consists of largely fluvial sediments which were deposited on the floodplains of these rivers. In time the land became progressively more arid and was covered with windblown sand just before the end of the basin's cycle. Finally the subcontinent was inundated with basaltic lava to form the capping basalts of the Jurassic aged Drakensberg Group. During the Jurassic, the volcanic Drakensberg were formed and cracks in the earth's crust were filled with molten lava that cooled to form dolerite dykes. Magma injected horizontally between sediments, cooled down and formed horizontal sills of dolerite.

The flood plains of the Beaufort Group (Karoo Supergroup) are internationally renowned for the early diversification of land vertebrates and provide the worlds' most complete transition from early "reptiles" to mammals.

3.1 PALAEONTOLOGICAL HERITAGE

The project site is primarily represented by sedimentary rocks of the late Permian to early Triassic, Adelaide Subgroup, and Katberg Formation, Tarkastad Subgroup Beaufort Group. Karoo Dolerite is present in the proposed development area (Fig. 4). The dolerite represents magma intrusions into the Karoo Supergroup sediments during the Jurassic volcanic period which occurred during the breakup of Gondwana (183 ± 2Ma). The sills and dykes have thermally metamorphosed or baked the adjacent sediments and therefore fossils are absent from the Karoo Dolerite Suite.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content. Based on available biostratigraphic mapping it is evident that only the upper, Late Permian to Early Triassic, portion of the Adelaide Subgroup, Palingkloof Member and Katberg Formation of the Tarkastad Subgroup is present in the Noupoort district, most probably corresponding to the *Daptocephalus* and *Lystrosaurus* Assemblage Zones.

The *Daptocephalus* Assemblage Zone (AZ) expands into the lower Palingkloof Member of the Upper Balfour Formation (Groenewald & Kitching 1995, Rubidge 2005). This Assemblage Zone is characterized by the occurrence of the two therapsids namely *Dicynodon* and *Theriognathus*. The *Daptocephalus* AZ of the Beaufort Group shows the greatest vertebrate diversity and includes numerous well preserved genera and species of dicynodonts, biarmosuchians, gorgonopsian, therocephalian and cynodont therapsid Synapsida as well as captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Pisces. Fossil plants of the Balfour Formation are relatively rare compared

to the vertebrate fossil assemblages. The presence of the wood genera, *Agathoxylon* and *Australoxylon,* was described by Bamford (2004).

The lower Palingkloof Member is of special importance as it precedes the Permo-Triassic Extinction Event which destroyed the vertebrate fauna and extinguished the diverse glossopterid plants. The lower *Lystrosaurus* Assemblage Zone forms part of the Katberg Formation. Fauna and flora from this assemblage zone is relatively rare as few genera survived the Permo-Triassic Extinction Event. The *Lystrosaurus* Assemblage Zone is characterized by the dicynodont, *Lystrosaurus* (the most abundant fossil in this biozone contributing up to 95% of fossils found) (Smith & Botha 2005, Botha & Smith 2007), and captorhinid reptile, *Procolophon*. The biarmosuchian and gorgonopsian Therapsida did not survive into the *Lystrosaurus* Assemblage Zone although the therocephalian and cynodont therapsids are present in moderate quantities. Burrowing tetrapods include various cynodonts, procolophonids and *Lystrosaurus* (Groenewald 1991, Groenewald and Kitching, 1995, Damiani *et al.* 2003, Abdala *et al.* 2006, Modesto & Brink 2010). Captorhinid Reptilia are reduced, but this interval is characterised by a unique diversity of oversize amphibians. Fossil fish, millipedes and diverse trace fossils have also been recorded.

These fossils are worldwide of palaeontological importance because they document the extinction and recovery of terrestrial biotas before and after the catastrophic end-Permian Mass Extinction event (approximately 251 million years ago). Several Early Triassic vertebrate fossil localities have already been recorded in close proximity to Noupoort and are represented in museum collections (*e.g.* Centre of Evolutionary Studies, School of Geosciences, University of the Witwatersrand Johannesburg; Iziko Museums, Cape Town; National Museum, Bloemfontein).

3.2 GEOLOGY

The Adelaide Subgroup consists of greenish or blue grey and greyish-red mudstones and sandstones (South African Committee for Stratigraphy, 1980; pp. 538-539). The strata of the Katberg Formation are far more sandstone dominated than those of the underlying Balfour Formation. The underlying Balfour Formation was essentially deposited by meandering rivers while the Katberg Formation was deposited by braided river systems. This could have been a result of the Permian-Triassic Extinction event which occurred during deposition of the uppermost Balfour Formation. Extinction of the dominant *Glossopteris* – flora will have led to more erosion which eventually changed the sedimentation system.

4 GEOGRAPHICAL LOCATION OF THE SITE

Site Location:

31°10'4.90"S, 24°55'7.26"E.

The proposed development area is located in an area of low relief without sharp outcrops. The development footprint is located approximately 4 km North West of Noupoort on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province (Fig.1). The Noupoort CSP Project is only one of various renewable energy projects present in the Noupoort area (Fig.) 2).

5 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the development footprint proposed for the Noupoort CSP Project was conducted on the 5 August 2016, to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2015), topographical and geological maps and other reports from the same area were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

5.1 ASSUMPTIONS AND LIMITATIONS

The accuracy and reliability of desktop Palaeontological Impact Assessments as components of heritage impact assessments are normally limited by the following restrictions:

- Old fossil databases that have not been kept up-to-date or are not computerised. These databases do not always include relevant locality or geological information. South Africa has a limited number of professional palaeontologists that carry out fieldwork and most development study areas have never been surveyed by a palaeontologist.
- The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- Impact studies and other reports (*e.g*. of commercial mining companies) - is not readily available for desktop studies.

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on the possible occurrence of fossils in an unexplored area. Desktop studies of this nature therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks

or potentially fossiliferous superficial sediments are present in the study area, the reliability of a Palaeontological Impact Assessment may be significantly improved through field-survey by a professional palaeontologist.

In order to ensure that an accurate description of the area proposed for the development is considered a field survey was undertaken to ground truth any potential impacts that the facility may have on the palaeontological resources of the site. The field-survey was undertaken on 5 August 2016, as indicated in Section 5 above.

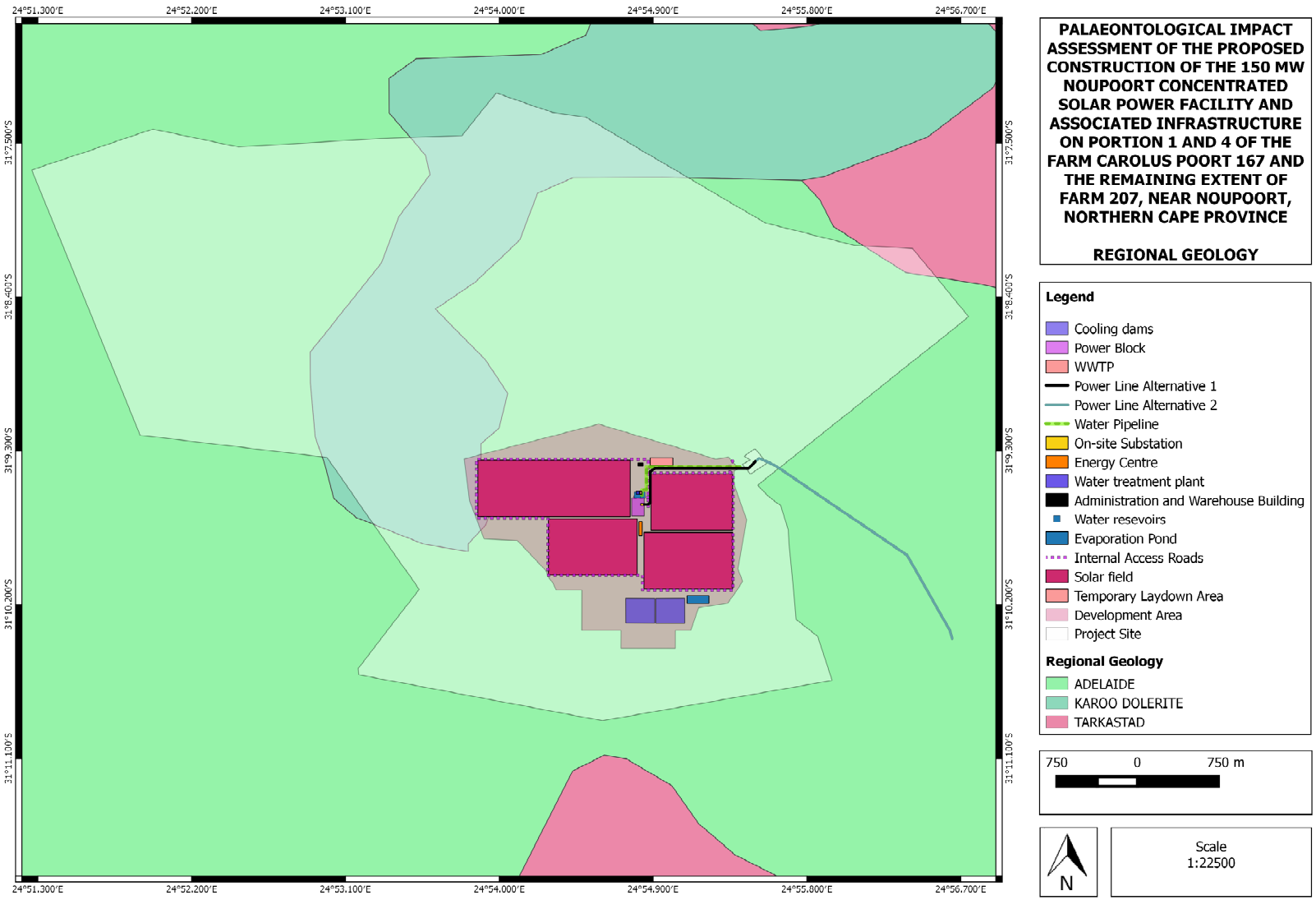

Figure 2. The surface geology of the proposed Noupoort CSP Project on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207, north west of Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province. (Modified from the 1: 250 000 Geological Map, 3124 Middelburg (Council for Geoscience, Pretoria).

6 Field Observations

Figure 3. Vegetation and low relief in the development footprint of the CSP facility in Noupoort on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207, north west of Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province.

The following photographs were taken on a site visit to Noupoort on Portion 1 and 4 of Carolus Poort 167 and the Remaining Extent of Farm 207 on 5 August 2016. The proposed development footprint is currently used as agricultural land.

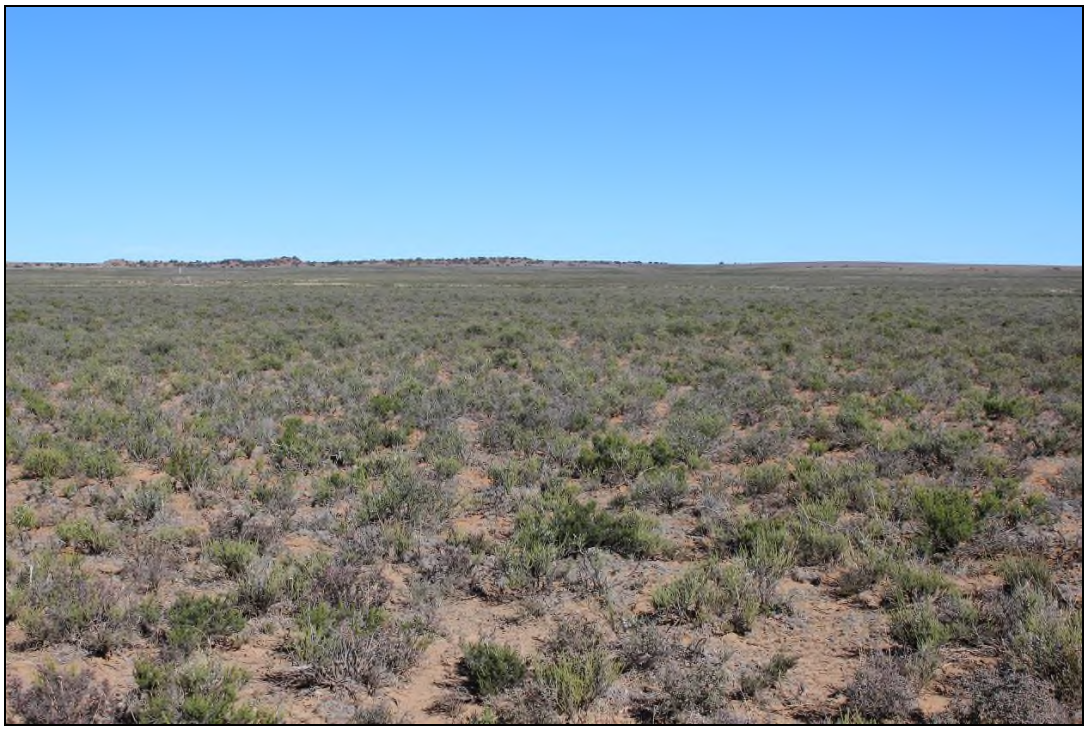

Figure 4. Vegetation and low relief in the development footprint of the CSP facility in Noupoort.

Figure 5. The existing 132kV Newgate Substation situated directly adjacent to the development area.

7 IMPACT ASSESSMENTS

An assessment of the impact significance of the proposed Noupoort CSP Project on local fossil heritage is presented here:

7.1 Nature of the impact

The Noupoort CSP Project will include the following infrastructures:

- Solar collector field consisting of all systems and infrastructure related to the control and operation of the parabolic troughs;
- Energy Centre, including the storage media and heat exchanger;
- Power Block, containing the steam turbine and generator, as well as the air-cooled condenser and associated feed-water system and cooling dams;
- On-site project substation;
- A new 132kV power line to connect the on-site substation to the Eskom's electricity grid;
- Access roads and fencing around the development area;
- Lined evaporation pond;
- Auxiliary boilers for facility start-up/shut-down/maintenance of boiler and steam production stability;
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- Offices and workshop areas for maintenance and storage; and
- Temporary laydown areas.

The trough technology designed for this project will be based on a floating field concept. This concept provides above ground installation of parabolic trough sections using a set of rails. Extensive bedrock excavations are not envisaged, but vegetation will need to be trimmed to an acceptable height. Vegetation beneath the trough mirrors will not be cleared but only trimmed to an acceptable height. The heat transfer media (HTF) is water based, non-toxic and inexpensive and permits operating at high temperature without typical operational problems e.g. freezing.

The facility's grid connection point will be finalised based on input from Eskom and the environmental assessment. Two alternative routes have been assessed:

- Direct connection to the existing 132kV Newgate Substation (situated directly adjacent to the development area) and
- Direct connection to the 66kV Noupoort Substation (located 3 km south-east of the development area), and the Newgate Substation.

Although minimal, the installation of project component will involve excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research. According to the Geology of the study area, there is a high possibility of finding fossil heritage during the construction phase of the project. No impacts are expected to occur during the operation phase.

7.2 Sensitive areas

The development footprint is centrally underlain by the Adelaide Subgroup, and an extremely small portion of Tarkastad Subgroup in the north, as well as unfossiliferous Karoo dolerite towards the west (Fig. 4). Although fossil heritage could be present in the Adelaide and Tarkastad Subgroup the likelihood of significant fossil heritage in the development area is considered to be of **low significance.** This could be attributed to the scarcity of fossils and the lack of exposure in the development area.

7.3 Geographical extent of impact

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

7.4 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**.

7.5 Potential significance of the impact

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

7.6 Severity / benefit scale

The development of the proposed Noupoort CSP Project is **beneficial** on not only a local level, but regional and national levels as well. The facility will provide a long term benefit to the surrounding communities 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.

7.7 Probability of the impact occurring

Impacts on palaeontological heritage during the construction phase could potentially occur but are regarded as improbable.

7.8 Intensity

The intensity of the impact on fossil heritage is rated as **low.**

7.9 Assessment of power line route alternatives

The grid connection point for the facility will be finalised based on input from Eskom and the environmental assessment. However, two alternative routes have been assessed:

- Direct connection to the existing 132kV Newgate Substation (situated directly adjacent to the development area) and
- Direct connection to the 66kV Noupoort Substation (located 3 km south-east of the development area), and the Newgate Substation.

Both power line alternatives are underlain by Adelaide Subgroup. The lack of relevant exposure in these power line corridors indicate that the likelihood of significant fossil heritage to occur is considered to be low.

7.10 Assessment of the area proposed for the development

The development footprint is underlain by the late Permian to early Triassic, Adelaide and Tarkastad Subgroup, while unfossiliferous Karoo Dolerite is also present. Although it is possible that the sediments of the Adelaide and Tarkastad Subgroup may contain fossils, this is considered highly unlikely due to the absence of appropriate exposure at the proposed site.

8 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

8.1 Mitigation

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

8.2 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective. 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.

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

Stratigraphic and geographical distribution of Adelaide Subgroup fossils, is documented in the literature. It is thus **possible** that exceptional fossil material is present on the development area. By taking a precautionary approach, a significant loss of fossil resources is not expected.

8.4 CUMULATIVE IMPACTS

Seventeen (17) renewable energy projects are situated in close proximity (30km) to the proposed development project, which include two preferred bidder projects (see Fig.6, Table 1). Sixteen of these projects are PV facilities, and one a wind energy facility. There are no other CSP facilities proposed or authorised in the area. Although these renewable energy projects have each an impact on their specific development footprint, as a whole the cumulative impacts is low.

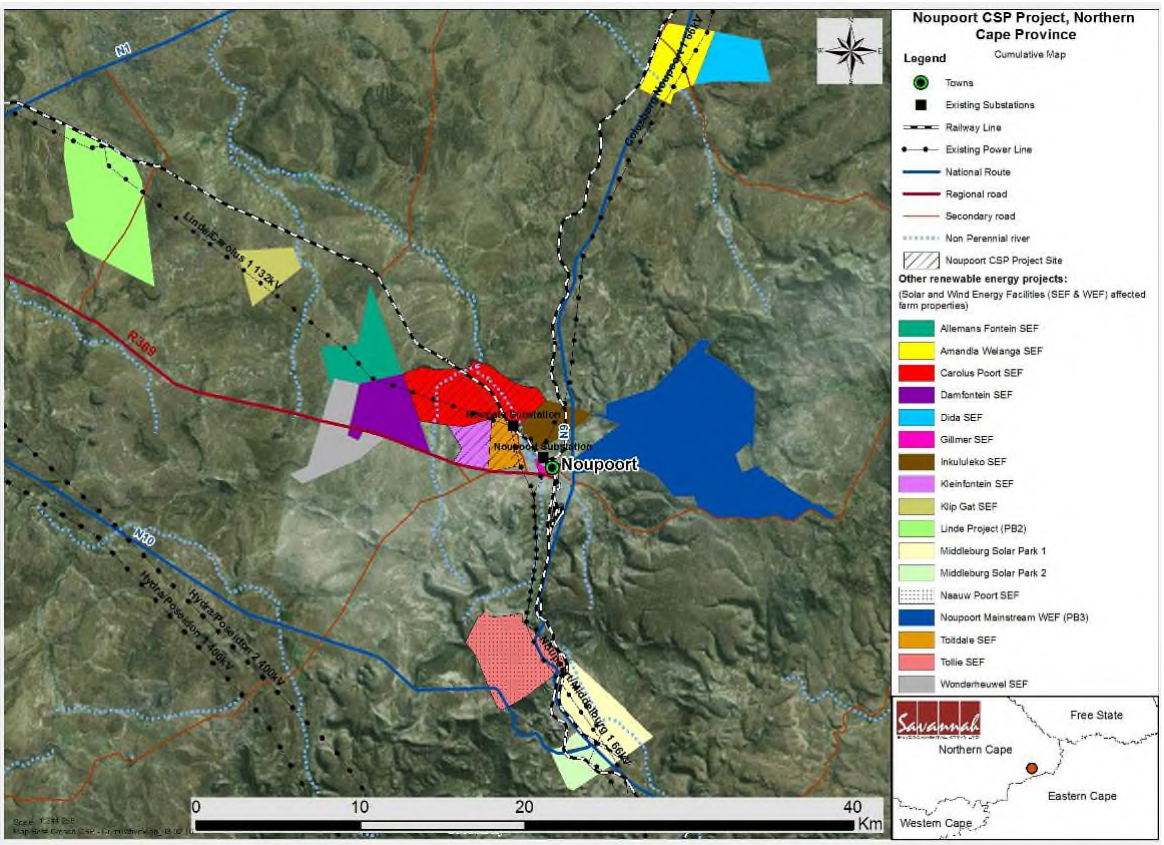

Figure 6. Location of renewable energy projects in the Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province. (Map provided by Savannah Environmental).

Table 1. Table of renewable energy projects in the Noupoort, Umsobomvu Local Municipality and within the greater Pixley ka Seme District Municipality, Northern Cape Province. (Table provided by Savannah Environmental).

Project Name	Location	Approximate distance from the proposed Noupoort CSP Project site	Project Status
Allemans Fontein Solar Energy Facility	Remainder of Farm Allemans Fontein 83	Located 9.6km north west of the proposed study area	Received Authorisation
Amandla Welanga Solar Energy Facility	Remaining extent of Farm Rietfontein 140	Located 25.2km north east of the proposed study area	Received Authorisation
Carolus Poort Solar Energy Facility	Remainder of the Farm Carolus Poort No. 207	Located within the proposed farm portions	Received Authorisation
Damfontein Solar Energy Facility	Portion 8 of the Farm Damfontein 114	Located 7km north west of the proposed study area	Received Authorisation
Dida Solar Energy Facility	Portion 3 of the Farm Rietfontein	Located 27km north east of the proposed study area	Received Authorisation
Gillmer Solar Energy Facility	Farm Noupoort No. 306	Located 2.5km south east of the proposed study area	Received Authorisation
Inkululeko Solar Energy Facility	Portion 2 of the Farm Carolus Poort 167	Located adjacent (less than 500m) east of the proposed study area	Received Authorisation
Kleinfontein Solar Energy Facility	Portion 4 of the Farm Caroluspoort 167	Located within the proposed farm portions	Received Authorisation
Klip Gat Solar Energy Facility	Portion 2 of the Farm Klip Gat 80	Located 17.8km west of the proposed study area	Received Authorisation
Linde Project (Solar Energy Facility)	Remaining extent and portion 1 of the Farm Van der Linderskraal No 79	Located 28.3km north west of the proposed study area	Received Authorisation and Preferred Bidder Round 2 (project constructed and operational)
Middleburg Solar Park 1	Remaining extent of Portion 4 of Farm Twee Fontein 11	Located 17.6km south east of the proposed study area	Received Authorisation
Middleburg Solar Park 2	Remainder of Farm Twee Fontein 11	Located 19.4km south east of the proposed study area	Received Authorisation
Naauw Poort Solar Energy Facility	Remaining extent of Portion 1 of the Farm Naauw Poort	Located 12.9km south of the proposed study area	Received Authorisation

Noupoort Mainstream Wind Energy Facility	Remainder of the Farm 168, Portion 1 of the Farm Holbrook 181, Portion 21 of the Farm Hartebeest Hoek 182	Located 10.3km east of the proposed study area	Received Authorisation and Preferred Bidder Round 3
Toitdale Solar Energy Facility	Portion 1 of the Farm Caroluspoort 167	Located within the proposed farm portions	Received Authorisation
Tollie Solar Energy Facility	Remaining extent of Portion 1 of the Farm Naauw Poort 1	Located 12.9km south of the proposed study area	Received Authorisation
Wonderheuwel Solar Energy Facility	Portion 7 of the Farm Damfontein No. 114.	Located 10.2km west of the proposed study area	Received Authorisation

9 FINDINGS AND RECOMMENDATIONS

The development footprint is primarily represented by sedimentary rocks of the late Permian to early Triassic, Adelaide and Tarkastad Subgroup, Beaufort group, Karoo Supergroup, while Karoo Dolerite is also present in the proposed development footprint.

The Balfour and Katberg Formations underlying the development footprint form part of the *Daptocephalus and Lystrosaurus a*ssemblage zones. These biostratigraphic zones include a rich and diverse vertebrate fauna of exceptionally high scientific significance due to their part in recording the evolutionary transition from reptiles to mammals.

However, the scarcity of fossil heritage and a lack of appropriate exposure at the proposed development footprint indicate that the impact of the Noupoort CSP Project on Portion 1 and 4 of the Farm Carolus Poort 167 and the Remaining Extent of Farm 207 is of low significance in palaeontological terms. Considering impacts, including cumulative impacts, **it can be concluded that the construction and operation of the Noupoort CSP Project and associated power line is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area.**

It is thus recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, pending the discovery or exposure of any fossil remains during the construction phase.

Should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist.

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

10 ASSESSMENT OF IMPACTS

10.1 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) x P

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

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

Nature: The solar field will be installed on a set of rails with no need for land levelling and minimal ground disturbance. Although minimal, the excavations and ground disturbance during the construction phase will involve excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research.

This impact is likely to occur only within the construction phase. No impacts are expected to occur during the operation phase.

	Without mitigation	**With mitigation**
Extent	Local(1)	N/A
Duration	Long term/permanent (4)	N/A
Magnitude	Minor (2)	N/A
Probability	Improbable (2)	N/A
Significance	**Low (14)**	N/A
Status (positive or negative)	Negative	N/A
Reversibility	Irreversible	N/A
Irreplaceable loss of resources?	No	N/A
Can impacts be mitigated?	Not Necessary	

Mitigation: Not necessary

The development area is primarily represented by sedimentary fossiliferous rocks of the late Permian to early Triassic, Adelaide and Tarkastad Subgroup, Beaufort group, Karoo Supergroup, while unfossiliferous Karoo Dolerite is also present in the proposed development area. The lack

of appropriate exposure at the proposed development footprint indicates that the impact of the Noupoort CSP Project is of low significance in palaeontological terms.
Residual Risk: Not applicable.

- < 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).

11 ASSESSMENT OF IMPACTS ASSOCIATED WITH THE CONSTRUCTION OF 132kV POWER LINE

Nature: Two alternative power line routes (including a 300m corridor) and a water pipe line have been assessed.

Both power line alternatives and water supply line are underlain by Adelaide Subgroup. The scarcity of fossil heritage and low relief, with no steep river gullies or sharp outcrops at the proposed development footprint, indicate that the impact of the proposed power line routes, and the likelihood of significant fossil heritage to occur is considered to be low.

This impact is likely to occur only within the construction phase. No impacts are expected to occur during the operation phase.

	Alternative 1 Direct connection to the Newgate Substation via a 132kV power line (~ 1.3km in length)		**Alternative 2** Direct connection to the 66kV Noupoort Substation and the Newgate Substation via a 132kV power line (~ 4km in length).		**Water pipeline** (~ 1,4km in length)	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local(1)	N/A	Local(1)	N/A	Local(1)	N/A
Duration	Long term/permanent (4)	N/A	Long term/permanent (4)	N/A	Long term/permanent (4)	N/A
Magnitude	Minor (2)	N/A	Minor (2)	N/A	Minor (2)	N/A
Probability	Improbable (2)	N/A	Improbable (2)	N/A	Improbable (2)	N/A

Significance	**Low (14)**	N/A	**Low (14)**	N/A	**Low (14)**	N/A
Status (positive or negative	Negative	N/A	Negative	N/A	Negative	N/A
Reversibility	Irreversible	N/A	Irreversible	N/A	Irreversible	N/A
Can impacts be mitigated?	Not Necessary	N/A	Not Necessary	N/A	Not Necessary	N/A
Mitigation: Not necessary The development area is primarily represented by sedimentary fossiliferous rocks of the late Permian to early Triassic, Adelaide and Tarkastad Subgroup, Beaufort group, Karoo Supergroup, while unfossiliferous Karoo Dolerite is also present in the proposed development area. The lack of appropriate exposure at the proposed development footprint indicates that the impact of the Noupoort CSP Project is of low significance in palaeontological terms						
Residual Risk: Not applicable						

After the consideration of the power line alternatives it is concluded that both proposed power line routes are acceptable and appropriate from a palaeontological perspective and can all be considered as feasible options.

There is no preferred power line route as both routes have the same geology and low relief and thus have the similar low impact on the palaeontological heritage.

It can also be concluded that the proposed route for the water supply pipeline is considered to be acceptable.

12 ASSESSMENT OF CUMULATIVE IMPACTS

Nature: Cumulative impacts on fossil remains preserved at or beneath the ground surface.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (3)	Minor (3)
Probability	Very improbable (1)	Improbable (2)
Significance	**Low (16)**	**Low (16)**

Status (positive/negative)	Positive	Positive
Reversibility	Low	Low
Loss of resources?	No	No
Can impacts be mitigated?	Not Necessary	
Confidence in findings: High.		
Mitigation: Not necessary Sedimentary fossiliferous rocks of the late Permian to early Triassic, Adelaide and Tarkastad Subgroup, Beaufort group, Karoo Supergroup, while unfossiliferous Karoo Dolerite is also present in the proposed development area. The lack of appropriate exposure at the proposed development footprint indicates that the impact of the Noupoort CSP Project and other renewable energy facilities in the area is of low significance in palaeontological terms.		

13 RECOMMENDATIONS CONCERNING FOSSIL HERITAGE MANAGEMENT DURING THE CONSTRUCTION PHASE

OBJECTIVE: Prevent the loss of Palaeontological Heritage		
Project component/s	Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography. Project components include: • Solar collector field; • Energy Centre; • Power Block,; • On-site project substation; • A new 132kV power line; • Access roads and fencing around the development area; • Lined evaporation pond; • Auxiliary boilers for the start-up process of the facility; • Water supply pipeline; • On-site water storage tanks/reservoirs; • Water treatment facility; • Waste water treatment facility; • Plant assembly facility; • Buildings; and • Temporary laydown areas	
Potential Impact	Disturb damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study.	
Activity/risk source	• Activities associated with the construction of the CSP facility.	
Mitigation: Target/Objective	Protection of identified fossils uncovered during the construction phase.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Should fossil material exist within the development footprint any negative impact upon it could be mitigated by surveying, recording, describing and sampling of well-preserved fossils by a professional palaeontologist. This should take place after initial vegetation clearance has taken place.	ECO	Construction phase

Excavation of fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.		

Performance Indicator	• No impacts on valuable fossil resources.
Monitoring	None.

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Elize Butler has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working at the National Museum since 1993 and currently holds the position of Collection Manager of the Karoo Vertebrate Collection of the Palaeontology Department at the National Museum in Bloemfontein. Her current research interests comprise of Permo-Triassic vertebrate palaeobiology, with a special focus on gorgonopsians at the End-Permian Mass Extinction. 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 10 years.

Declaration of Independence

I, Elize Butler, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.

Sincerely

Mrs. Elize Butler