THE BASIC ASSESSMENT FOR THE PROPOSED KOMAS WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE NEAR KLEINSEE IN THE NORTHERN CAPE PROVINCE.

Palaeontology Assessment

PALAEONTOLOGICAL IMPACT ASSESSMENT

PROPOSED GROMIS AND KOMAS WIND ENERGY FACILITIES AND ASSOCIATED POWER LINES AND ELECTRICAL INFRASTRUCTURE NEAR KLEINSEE IN THE NAMA KHOI LOCAL MUNICIPALITY, NAMAKWALAND MAGISTERIAL DISTRICT, NORTHERN CAPE PROVINCE

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For

Genesis ENERTRAG Gromis Wind (Pty) Ltd and Genesis ENERTRAG Komas (Pty) Ltd

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EXECUTIVE SUMMARY

1. Project Name

The proposed **Gromis and Komas** Wind Energy Facilities (WEFs) and associated power lines and electrical infrastructure near Kleinsee in the Northern Cape Province.

2. Location

The proposed Gromis and Komas WEFs and associated infrastructure are located approximately 25 to 40 km southeast of Kleinsee in the Nama Khoi Local Municipality, Namakwa District Municipality, Namakwaland Magisterial District, Northern Cape Province (Figures 1 & 2). The affected properties are listed in Table 1.

3. Locality Plan

See Figures 1 and 2.

4. Proposed Development

It is proposed that the Gromis WEF development will consist of up to 33 wind turbines and associated infrastructure with a total generation capacity of up to 200 MW. The proposed Komas WEF will consist of up to 50 turbines and associated infrastructures with a total generation capacity of up to 300 MW. The dimensions of components for both WEFs and associated infrastructure are as follow:

- Turbines with a hub height of up to 200 m and a rotor diameter of up to 200 m.
- Hardstand areas of approximately 1 500 m^2 per turbine.
- Temporary construction laydown and storage area of approximately 4 500 m^2 per turbine.
- Medium voltage cabling connecting the turbines will be laid underground.
- Internal roads with a width of up to 10 m providing access to each turbine and accommodating cable trenches and stormwater channels, as required. Existing roads will be upgraded wherever possible, although new roads will be constructed where necessary.
- A temporary construction laydown/staging area of approximately 22 500 m^2 which will also accommodate the operation and maintenance (O&M) buildings.
- A 33/132 kV on-site Substation (SS) of approximately 1 hectare (ha) to feed electricity generated by each proposed WEF into the national grid at the Gromis Main Transmission Substation (MTS).

The proposed WEF development areas are indicated by red polygons and power line routes are indicated by yellow lines (Figures 1 and 2). Four separate Basic Assessments (BAs) will be undertaken: one for each WEF and one for each associated power line and electrical infrastructure. The Palaeontological Impact Assessment (PIA) includes the assessments of all four projects.

Please note that the figured maps herein show the interim layouts and not the subsequent adjustments. The adjustments to the layout of the turbines and infrastructure do not affect this assessment as the recommended mitigation measures are applicable in the Project Area regardless of the exact layout. The palaeontological impact relates to the sensitivity of the geological formations and scale of excavations and not the exact positions of project components.

5. Affected Formations

The affected surficial formations include Holocene dunes of the **Hardevlei Formation** and earlier late Quaternary coversands of the **Koekenaap Formation**. Beneath these unconsolidated sands are compact, pedogenically-altered aeolianites termed the **Dorbank Formation** which are fossil dune plumes of later mid-Quaternary age (Figures 2, 5, 8). Between the fossil dune plume ridges is a non-depositional area (Zonnekwa Valley, Figure 8) which is closely underlain by pale calcrete pedocrete which is likely to have formed within the upper part of an older aeolianite formation such as correlates of the Olifantsrivier or Graauw Duinen formations.

6. Palaeontological Resources

The fossil content of the aeolian formations is presumed to be typical of that observed in correlative formations in the wider area. Fossil material most commonly seen is the ambient fossil content of dune sands: land snails, tortoise shells and mole bones. The bones of larger animals (*e.g.* antelopes, zebra, rhinos) are sparse, but are more persistently present along palaeosurfaces which separate the major aeolianite formations where they are enclosed in palaeosols and pedocretes, and also occur on cryptic palaeosurfaces within formations. Rare large caches of bones in large burrows are due to the bone-collecting behaviour of hyaenas.

7. Anticipated Impact

The primary palaeontological concern is the fossil bones that are sparsely distributed in these aeolian deposits. In the Hardevlei and Koekenaap formations the fossil bone and marine shell material that may occur is likely to be in an archaeological context. Both artefacts and fossil bones are most often found on the compact palaeosurface of the Dorbank Formation. beneath the surficial sands. The fossil bone material would be of late Quaternary age and comprised mainly of extant species (modern fauna), but could include species that did not historically occur in the region.

The fossil bone finds in the Dorbank Formation are generally the scattered, disarticulated and sometimes fragmented larger limb bones of antelopes and zebra. Pans and vleis/seep deposits, with greater fossil potential, may occur along buried drainage lines within the Dorbank Formation. Most finds have been at lower elevations in diamond-mine pits and little is known of this formation and its fossils at higher elevations and in this region of the coastal plain. Fossil finds could prove to be a scientifically significant addition to the poorly-known later mid-Quaternary fossil fauna of Namaqualand.

The calcrete-floored Zonnekwa Valley has very likely hosted pans during wetter climate spells in the past. It is possible that some pan deposits may remain, or fossils that have been eroded from them by wind deflation. The calcrete is assumed to have formed within the upper part of an older aeolianite formation. As the capping calcrete has formed along a persistent palaeosurface, fossil bones are more prevalent within it and are expected to be of earlier Quaternary age.

Due to the overall sparse distribution of fossil bones in the affected formations the palaeontological sensitivity and intensity of **impact is considered to be LOW before and after mitigation for all excavations involved in the construction of the proposed Gromis and Komas WEFs and associated infrastructure**. However, when fossils are found in such poorly fossiliferous formations, they provide very significant advances in the geological understanding of the stratigraphy of a region.

There will be a considerable number of excavations for turbine foundations (*e.g*. ~33 for Gromis and 50 for Komas WEFs) distributed over and “sampling” a wide area during the construction phase. Therefore, in spite of the overall low fossil potential, there is a distinct possibility that buried palaeosurfaces bearing fossil bones and archaeological material may be exposed in some of the excavations. The excavations for cabling and other infrastructure such as the substations are relatively shallow and mainly affect the coversands, but the cabling trenches will traverse considerable lengths across the proposed WEFs development areas and intersect the locally-fossiliferous top of the Dorbank Unit in places. **The foundations of the power line pylons that connect to the national grid at the Gromis MTS are more minor in scale and have a lower likelihood of impact, although not altogether absent.**

SUMMARY OF ASSESSMENTS OF IMPACTS TO PALAEONTOLOGICAL RESOURCES DURING THE CONSTRUCTION PHASE– GROMIS AND KOMAS WEFs AND ASSOCIATED INFRASTRUCTURE AS WELL AS POWER LINES AND ASSOCIATED ELECTRICAL INFRASTRUCTURE– ALL AEOLIAN FORMATIONS.		
	Without mitigation	**With mitigation**
Significance	Low	Low
Status	Negative	Positive
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Partly
Can impacts be mitigated?	Yes, but only partial mitigation is possible. Scientifically significant fossils may be lost in spite of management actions to mitigate such loss.	
Mitigation:	• Monitoring of all construction-phase excavations. • Inspection, sampling and recording of selected exposures in the event of fossil finds. • Fossil finds and contextual reports deposited in a curatorial scientific institution.	
Cumulative impact	• The inevitable and permanent loss of fossils.	

8. Recommendations

For all excavations during the construction phase of the proposed Gromis and Komas WEFs and associated infrastructure as well as the power lines and associated electrical infrastructure the **LOW palaeontological sensitivity and the LOW level of significance indicates that the potential palaeontological impact does not significantly influence the decision to construct the WEFs or the associated power lines and electrical infrastructure,** however appropriate mitigation measures are required. **Therefore, the proposed development of the WEFs and associated infrastructure as well as the power lines and associated electrical infrastructure is considered to be acceptable from a palaeontological perspective and can be authorised, subject to the implementation of the recommended mitigation measures.**

Potential adjustments to the layout of the turbines and infrastructure do not affect this assessment.

A recommendation to be included in the Environmental Management Programme (EMPr) is to be alert for possible fossils and buried archaeological material during the Construction Phase of the proposed Gromis and Komas WEFs and associated infrastructure as well as the power lines and associated electrical infrastructure. A Fossil Finds Procedure (Appendix 4) should also be in place.

The field supervisor/foreman and staff involved in excavations during the construction phase of both WEF and associated power lines and electrical infrastructure projects, must be informed of the need to look out for fossils and buried potential archaeological material. In the event of staff sighting potential fossils or buried archaeological material during construction; staff are to cease work at the location of the sighting and report the potential find to the field supervisor who, in turn, must report to the Environmental Control Officer (ECO). The ECO must inform the developer and contact the palaeontologist contracted to be on standby in the case of fossil finds. The latter must liaise with the South African Heritage Resource Agency (SAHRA) on the nature of the find and consequent actions (permitting and collection of find).

If palaeontological mitigation is applied during the construction phases of the proposed Gromis and Komas WEFs and associated power lines and electrical infrastructure as recommended, it is possible that these WEFs will to some extent alleviate the negative cumulative impact on paleontological resources in the region. The history of these vast tracts of sands, gravels and pedocretes of the Northern Cape Province is very poorly known, with very few fossils to rely on.

Therefore, any fossil bone find will be of considerable importance and could add to the scientific knowledge of the area in a positive manner. The fossil bones that have been found hitherto in the aeolianites of Namaqualand attest to the fossil potential that will be delivered by the continuation of systematic searches for these sparse remains.

CONTENTS

ABBREVIATIONS

asl.:	above (mean) sea level
EPWP:	Early Pliocene Warm Period
ESA:	Early Stone Age
Fm.:	Formation
LIG:	Last Interglacial
LPWP:	Late Pliocene Warm Period
MIS:	Marine Isotope Stage
MMCO:	Mid Miocene Climatic Optimum
MSA:	Middle Stone Age
MTS:	Main Transmission Substation
OSL:	Optically stimulated luminescence
PIA:	Palaeontological Impact Assessment
SAHRA:	South African Heritage Resources Agency
SS:	Substation

GLOSSARY

~ (tilde): Used herein as "approximately" or "about".

Aeolian: Pertaining to the wind. Refers to erosion, transport and deposition of sedimentary particles by wind. A rock formed by the solidification of aeolian sediments is an aeolianite.

Alluvium: Sediments deposited by a river or other running water (alluvial).

Archaeology: Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

Bedrock: Hard rock formations underlying much younger sedimentary deposits.

Calcareous: Sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite.

Calcrete: An indurated deposit (duricrust) mainly consisting of Ca and Mg carbonates. The term includes both pedogenic types formed in the near-surface soil context and non-pedogenic or groundwater calcretes related to water tables at depth.

Clast: Fragments of pre-existing rocks, *e.g.* sand grains, pebbles, boulders, produced by weathering and erosion. Clastic – composed of clasts.

Colluvium: Hillwash deposits formed by gravity transport downhill. Includes soil creep, sheetwash, small-scale rainfall rivulets and gullying, slumping and sliding processes that move and deposit material towards the foot of the slopes.

Conglomerate: A cemented gravel deposit.

Coversands: Aeolian blanket deposits of sandsheets and smaller dunes.

Duricrust: A general term for a zone of chemical precipitation and hardening formed at or near the surface of sedimentary bodies through pedogenic and (or) non-pedogenic processes. It is formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upward, downward, or laterally by capillary action, commonly assisted in arid settings by evaporation. Classified into calcrete, ferricrete, silcrete, gypcrete, sepiocrete etc.

Fluvial deposits: Sedimentary deposits consisting of material transported by, suspended in and laid down by a river or stream.

Fossil: The remains of parts of animals and plants found in sedimentary deposits. Most commonly hard parts such as bones, teeth and shells which in lithified sedimentary rocks are usually altered by petrification (mineralization). Also impressions and mineral films in fine-grained sediments that preserve indications of soft parts. Fossils plants include coals, petrified wood and leaf impressions, as well as microscopic pollen and spores. Marine sediments contain a host of microfossils that reflect the plankton of the past and provide records of ocean changes. Nowadays also includes molecular fossils such as DNA and biogeochemicals such as oils and waxes.

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

OSL: Optically stimulated luminescence. One of the radiation exposure dating methods based on the measurement of trapped electronic charges that accumulate in crystalline materials as a result of low-level natural radioactivity from U, Th and K. In OSL dating of aeolian quartz and feldspar sand grains, the trapped charges are zeroed by exposure to daylight at the time of deposition. Once buried, the charges accumulate and the total radiation exposure (total dose) received by the sample is estimated by laboratory measurements. The level of radioactivity (annual doses) to which the sample grains have been exposed is measured in the field or from the separated minerals containing radioactive elements in the sample. Ages are obtained as the ratio of total dose to annual dose, where the annual dose is assumed to have been similar in the past.

Palaeontology: The study of any fossilised remains or fossil traces of animals or plants which lived in the geological past and any site which contains such fossilised remains or traces.

Palaeosol: An ancient, buried soil formed on a palaeosurface. The soil composition may reflect a climate significantly different from the climate now prevalent in the area where the soil is found. Burial reflects the subsequent environmental change.

Palaeosurface: An ancient land surface, usually buried and marked by a palaeosol or pedocrete, but may be exhumed by erosion (*e.g.* wind erosion/deflation) or by bulk earth works.

Pedogenesis/pedogenic: The process of turning sediment into soil by chemical weathering and the activity of organisms (plants growing in it, burrowing animals such as worms, the addition of humus *etc.*).

Pedocrete: A duricrust formed by pedogenic processes.

Rhizolith: Fossil root. Most commonly formed by pedogenic carbonate deposition around the root and developed in palaeosols.

Sepiocrete: A duricrust with a high content of the magnesian clay mineral sepiolite.

Stone Age: The earliest technological period in human culture when tools were made of stone, wood, bone or horn.

Stratotype locality: The place where deposits regarded as defining the characteristics of a particular geological formation occur.

Tectonic: Relating to the structure of the earth's crust and the large-scale processes which take place within it (faulting and earthquakes, crustal uplift or subsidence.

Trace fossil: A structure or impression in sediments that preserves the behaviour of an organism, such as burrows, borings and nests, feeding traces (sediment processing), farming structures for bacteria and fungi, locomotion burrows and trackways and traces of predation on hard parts (tooth marks on bones, borings into shells by predatory gastropods and octopuses).

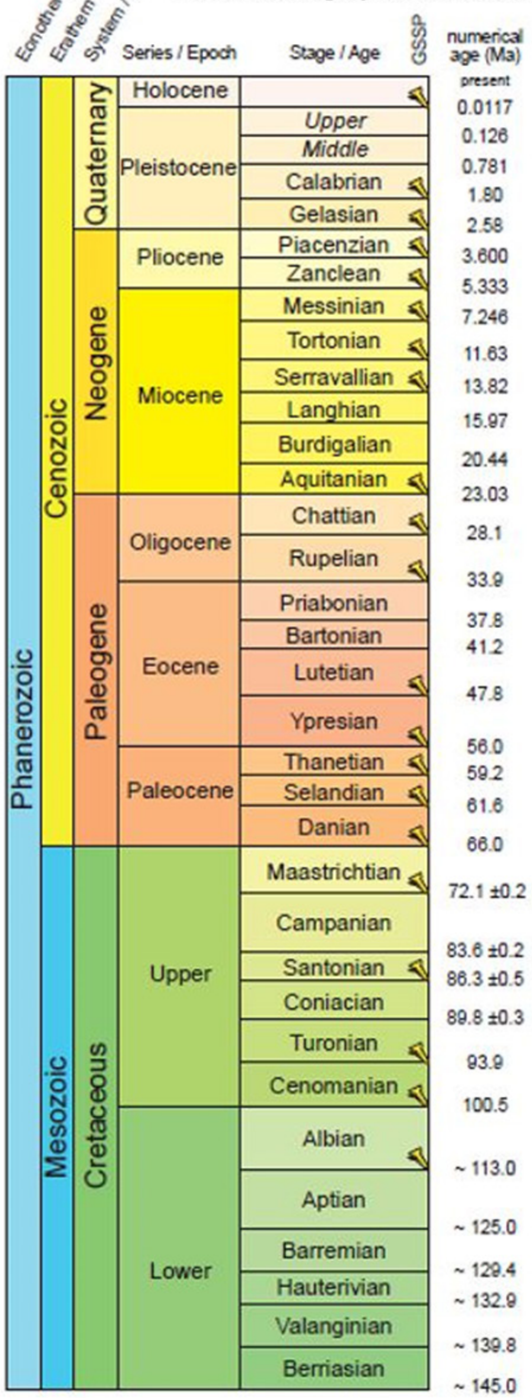
GEOLOGICAL TIME SCALE TERMS

ka: Thousand years or kilo-annum (10^3 years). Implicitly means “ka ago” *i.e*. duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Not used for durations not extending from the Present. For a duration only “kyr” is used.

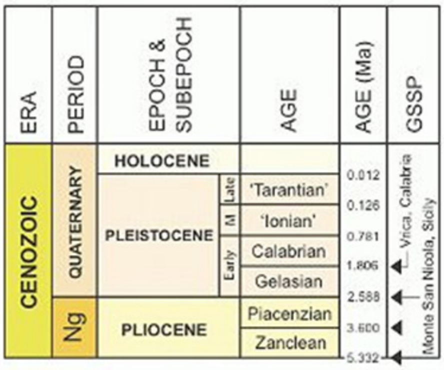
Ma: Millions years, mega-annum (10^6 years). Implicitly means “Ma ago” *i.e.* duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Not used for durations not extending from the Present. For a duration only “Myr” is used.

For more detail see www.stratigraphy.org.

Mesozoic and Cenozoic Chronostratigraphy
From: International Commission on Stratigraphy.
Chronostratigraphic Chart 2016-12.pdf



ICS-approved 2009 Quaternary (SQS/INQUA) proposal



Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka.
Late Pleistocene 11.7–126 ka.
Middle Pleistocene 135–781 ka.
Early Pleistocene 781–2588 ka.

Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era.
The Quaternary includes both the Pleistocene and Holocene epochs. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.

COMPLIANCE WITH APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R326 (7 April 2017)	Addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Appendix 1
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 2
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 5
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 9-11
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying alternatives;	Section 9
g) an identification of any areas to be avoided, including buffers;	N/A
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 6
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 11
k) any mitigation measures for inclusion in the EMPr;	Section 11
l) any conditions for inclusion in the environmental authorisation;	Section 11
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 11
n) a reasoned opinion- i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity and activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 11
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not Applicable
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not Applicable
q) any other information requested by the competent authority.	Not Applicable
2. Where a government notice gazetted by the Minister provides for any protocol of minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply	Part A of the Assessment Protocols published in Government Notice No. 320 on 20 March 2020 is applicable (i.e. Site sensitivity verification

	requirements where a specialist assessment is required but no specific assessment protocol has been prescribed). See Appendix 3 in the Heritage Impact Assessment.

1 INTRODUCTION

Genesis ENERTRAG Gromis Wind (Pty) Ltd and Genesis ENERTRAG Komas (Pty) Ltd (“the applicants”) are proposing to develop the Gromis and Komas Wind Energy Facilities (WEFs) respectively and associated infrastructure near the coastal town of Kleinsee within the Nama Khoi Local Municipality, in the far western parts of the Northern Cape Province (Figure 1). The applicants are also proposing to develop the associated power lines and electrical infrastructure to supports these WEFs. The proposed WEFs are located within the Springbok Renewable Energy Development Zone (REDZ 8) and is therefore subject to a Basic Assessment (BA) instead of a full Environmental Impact Assessment (EIA).

The applicants have appointed the Council of Scientific and Industrial Research (CSIR) as the Environmental Assessment Practitioner to undertake the required BA processes to apply for Environmental Authorisation (EA) for the proposed projects. The CSIR in turn has appointed ASHA Consulting (Pty) Ltd to undertake a Heritage Impact Assessment (HIA) to assess the potential impacts of the proposed projects on the heritage resources.

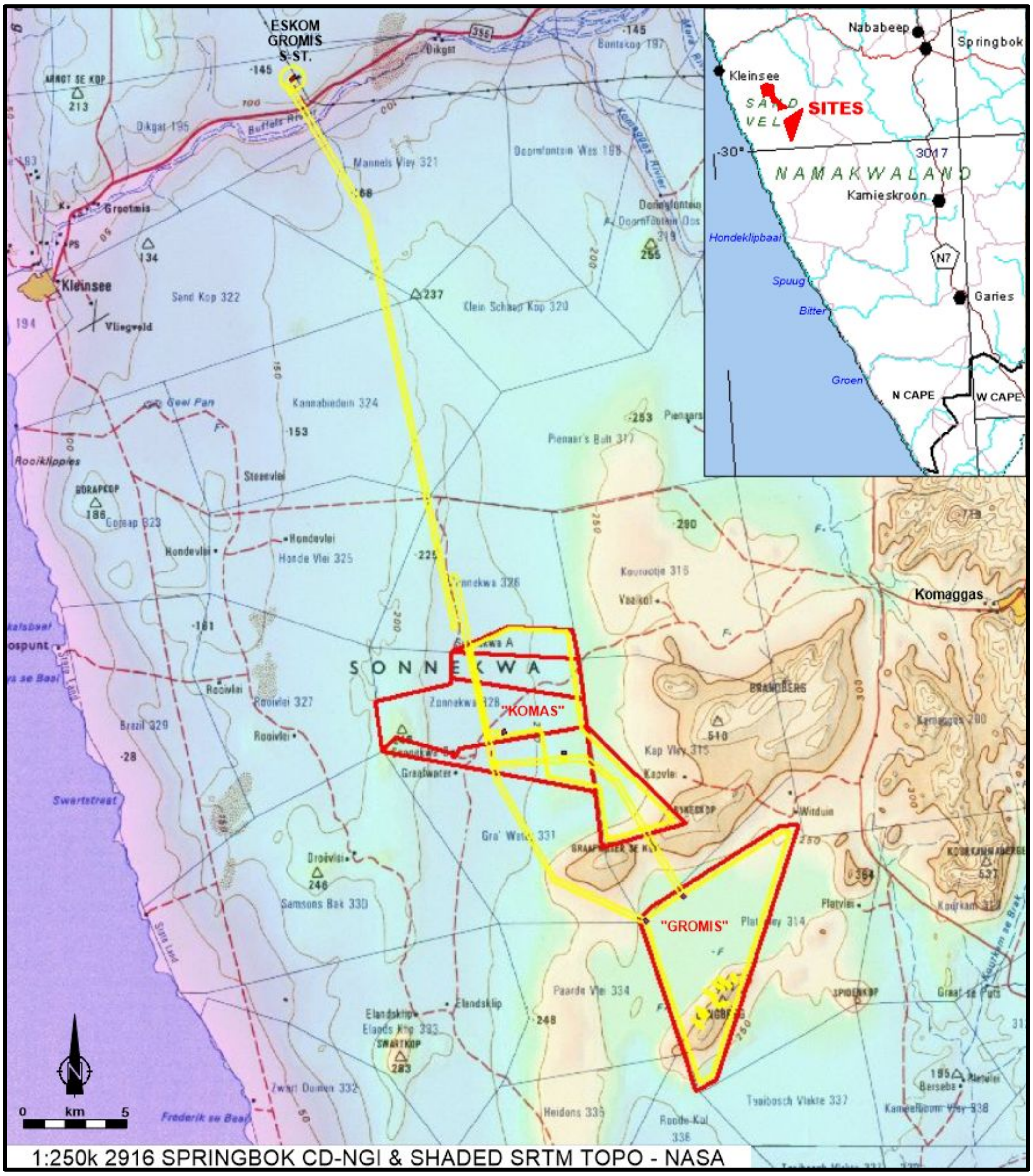


Figure 1. The proposed Gromis and Komas WEF Project Areas. Property boundaries in red and proposed development areas and proposed power line routes shown in yellow.

The Paleontological Impact assessment (PIA) forms part of the HIA and informs on; the palaeontological sensitivity of the proposed Gromis and Komas WEF development area, the probability of palaeontological materials (fossils) being uncovered in the sub-surface and being disturbed or destroyed in the constrution phase. The PIA also provides recommendations for palaeontological mitigation to be included in the Environmental Management Programme (EMPr) for the Construction Phase of the proposed Gromis and Komas WEFs and associated power lines and electrical infrastructrure. Four separate BAs will be undertaken: one for each WEF and one for the associated power line and electrical infrastructure for both the Gromis and Komas WEFs.

2 LOCATION

The proposed Gromis and Komas WEFs are located approximately 25 to 40 km southeast of Kleinsee in the Nama Khoi Local Municipality, Namakwa District Municipality, Namakwaland Magisterial District, Northern Cape Province (Figure 1).

For the proposed WEFs and powerline routes the relevant 1:250 000 map is Sheet 2916 SPRINGBOK and the 1:50 000 topo-cadastral maps are 2917CC BRAZIL, 2917CD KOMAGGAS and 2916DB & 2917CA KLEINSEE.

The properties involved are listed below:

TABLE 1. GROMIS AND KOMAS WEFS - AFFECTED FARM PORTIONS.

Wind Energy Facility	Farm portions
Gromis	Plat Vley 1/314
Komas	Zonnekwa 1/326
Komas	Zonnekwa 2/328
Komas	Zonnekwa 3/328
Komas	Zonnekwa 4/328
Komas	Kap Vley 4/315

The following additional properties are traversed by the proposed power line routes:

Gromis Power line:

- Portion 2 of the Farm Pienaars Bult No. 317
- Portion 4 of the Farm Dikgat No. 195
- Remainder of the Farm Dikgat No. 195
- Remainder of the Farm Mannels Vley No. 321
- Remainder of the Farm Leliefontein No. 322
- Remainder of the Farm Kannabieduin No. 324
- Remainder of the Farm Honde Vlei No. 325
- Remainder of the Farm Zonnekwa No. 326
- Portion 1 of the Farm Zonnekwa No. 326
- Portion 2 of the Farm Zonnekwa No. 328
- Portion 3 of the Farm Zonnekwa No. 328
- Portion 4 of the Farm Zonnekwa No. 328
- Remainder of the Farm Gra Water No. 331
- Remainder of the Farm Platvley No. 334
- Remainder of the Farm Paarde Vlei No. 315
- Portion 1 of the Farm Platvley No. 314

Komas Power line:

- Portion 2 of the Farm Pienaars Bult No. 317
- Portion 4 of the Farm Dikgat No. 195

- Remainder of the Farm Dikgat No. 195
- Remainder of the Farm Mannels Vley No. 321
- Remainder of the Farm Leliefontein No. 322
- Remainder of the Farm Kannabieduin No. 324
- Remainder of the Farm Honde Vlei No. 325
- Remainder of the Farm Zonnekwa No. 326
- Portion 1 of the Farm Zonnekwa No. 326
- Portion 2 of the Farm Zonnekwa No. 328
- Portion 3 of the Farm Zonnekwa No. 328

3 PROPOSED ACTIVITIES

It is proposed that the Gromis WEF will consist of up to 33 wind turbines and associated infrastructure with a total generation capacity of up to 200 MW. The proposed Komas WEF will consist of up to 50 wind turbines and associated infrastructure with a total generation capacity of up to 300 MW. The proposed WEF development areas are indicated by red polygons and proposed power line routes are indicated in yellow (Figures 1, 2, 5 and 8). The main earthworks involved are the excavations for the turbine foundations which have an approximate diameter of up to 25 m and will typically be approximately 3 m deep, however the majority of the site is expected to have hard excavation difficulties and therefore shallow foundation solutions with an anchoring system will likely be required.

The associated infrastructure consists of:

- internal access roads with a width of up to 10 m, including turning circle/bypass areas of up to 15 m providing access to each turbine and accommodating cable trenches and stormwater channels;
- temporary construction laydown and storage areas of approximately 4 500 m^2 per turbine;
- a temporary construction laydown/staging area of approximately 22 500m^2 which will also accommodate the operation and maintenance (O&M) buildings; and
- each WEF will have a 33/132 kV on-site Substation (SS) of approximately 1 hectare (ha) to feed electricity generated by the proposed WEF into the national grid at the Gromis MTS. Two on-site SS location alternatives are proposed for each WEF (i.e. Option 1 and Option 2) (Figures 2 & 8).
- Two power line route alternatives and two Eskom Switching SS assessment site alternatives (Option 1 and Option 2 for both alternatives) have been identified for assessment during the BA processes. The proposed power lines to the national grid at the Gromis MTS are intended to proceed along the planned Eskom Gromis-Juno 400 kV power line (Figure 1). Both power line routing alternatives include a connection into the already authorised Zonnequa Collector SS on the Remainder of the Farm Zonnekwa 326 and a proposed Collector SS on Portion 2 of the Farm Zonnekwa 328 as the location of the Collector SS is still unknown. An access road with a width of up to 8 m will be required to provide access to the substations and power line servitude.

4 APPROACH AND METHODOLOGY

The relatively few fossils from the Namaqualand coastal plain have been vital to our current understanding of the coastal-plain geological history, not only of Namaqualand, but the fossil findings are also relevant to the coastal plains of the wider southern Africa.

Deposits or formations are rated in terms of their potential to include fossils of scientific importance, *viz*. their palaeontological sensitivity. Palaeontological sensitivity refers to the likelihood of finding significant fossils within a geologic unit, which informs the Intensity/Magnitude/Severity rating in an impact assessment. The rating criteria are included in Appendix 3.

4.1 TERMS OF REFERENCE

- Comply with the Assessment Protocols that were published on 20 March 2020, in Government Gazette 43110, GN 320. This specifically includes Part A, which provides the Site Sensitivity Verification Requirements where a Specialist Assessment is required but no Specific Assessment Protocol has been prescribed.
- Provide a Site Sensitivity Verification Report based on the requirements documented in the Assessment Protocols published on 20 March 2020, in Government Gazette 43110, GN 320.
- Compile a Palaeontological Impact Assessment in compliance with the National Environmental Management Act, 1998 (Act 107 of 1998), as amended (NEMA) and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended. The Specialist Assessment must also be in adherence to any additional relevant legislation and guidelines that may be deemed necessary.
- The specialist must identify the sensitivity and land-use of the project area, and verify and confirm this against the findings of the National Screening Tool.
- Determination, description and mapping of the baseline environmental condition and sensitivity of the study area. Specify set-backs or buffers, and provide clear reasons for these recommendations, if relevant.
- Prepare and undertake a study on the palaeontology and fossil heritage within the proposed project area, based on:
  - a review of all relevant palaeontological and geological literature, including geological maps and previous reports;
  - location and examination of fossil collections from the study area (e.g. museums); and
  - data on the proposed development (e.g. location of footprint, depth and volume of bedrock excavation envisaged).
- Describe the type and location of known palaeontology and fossil heritage sites in the study area, and characterize all items that may be affected by the proposed project.
- Note fossils and associated sedimentological features of palaeontological relevance (photos, maps, aerial or satellite images, and stratigraphic columns).
- Evaluate the potential for occurrence of palaeontology and fossil heritage features within the study area.
- Identify and rate potential direct, indirect and cumulative impacts of the proposed project on the palaeontology and fossil heritage during the construction, operational and decommissioning phases of the project. Study the cumulative impacts of the project by considering the impacts of existing renewable energy plants within the area (as well as those proposed), together with the impact of the proposed project. Impact significance must be rated both without and with mitigation. The Impact Assessment Methodology must follow that as provided by the CSIR.
- Identify any protocols, legal and permit requirements that relevant to this project and the implications thereof.
- Provide recommendations and suggestions regarding fossil heritage management on site, including conservation measures, as well as promotion of local fossil heritage (e.g. for public education, schools) to ensure that the impacts are limited.
- Provide recommendations with regards to potential monitoring programmes.
- Determine mitigation and/or management measures which could be implemented to as far as possible reduce the effect of negative impacts and enhance the effect of positive impacts. Also identify best practice management actions, monitoring requirements, and rehabilitation guidelines for all identified impacts. This must be included in the EMPr.
- Incorporate and address all review comments made by the Project Team (CSIR and Project Applicant) during the various revisions of the specialist report.
- Incorporate and address all issues and concerns raised by Stakeholders (i.e. SAHRA, I&APs, Competent Authority and the public during the Public Participation Process (e.g. following the review of the Draft BA Report or where relevant and applicable).
- Review the Generic EMPr for Substations (GN 435) and confirm if there are any specific environmental sensitivities or attributes present on the site and any resultant site specific impact management outcomes and actions that are not included in the pre-approved generic EMPr (Part B – Section 1). If so, provide a list of these specific impact management outcomes and actions.

4.2 Available Information

This assessment is based on the published scientific literature on the origin and palaeontology of the Namaqualand coastal-plain deposits and the author's comprehensive field experience of the formations involved and their fossil content.

The relevant 1:250 000 Council for Geoscience geological maps and their explanations are Sheet 2916 SPRINGBOK (Marais *et al*., 2001) and Sheet 3017 GARIES (De Beer, 2010). The new stratigraphic terminology proposed by De Beer (2010) is mainly used, but is elaborated and modified according to the author's own observations. The annotated pertinent part of Sheet 2916 is presented in Figure 2. Relevant aspects of the regional geology are described below. References are cited in the normal manner and are included in the References section.

4.3 Assumptions and Limitations

The assumption is that the fossil potential of a formation will be typical of its genesis/depositional environment and more specifically, similar to that observed in equivalent deposits near the project areas. Scientifically important fossil material is expected to be very sparsely scattered in these deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations.

A limitation on predictive capacity exists in that it is not possible to predict the buried fossil content of an area or formation other than in such general terms.

5 ASPECTS OF THE REGIONAL GEOLOGY

5.1 The Bedrock

A sense of the underlying bedrock topography in the wider area is imparted by bedrock outcrops on the flanks and summits of hills and ridges (Figure 2). A prominent ridge with summits named Brandberg, Byneskop and Graafwater se Kop trends southwest between the proposed Gromis and Komas WEF development areas (Figures 1 & 2). The Komas WEF development area extends from ~175 m asl. in the northwest, rising towards the southeast where the southern area of Kap Vley 4/314 laps onto the northern slopes of the ridge at ~270 to 350 m asl. Another bedrock ridge named Langberg occupies the southern corner of the proposed Gromis WEF development area, with the intervening broad valley occupying most of Plat Vley Farm 1/314 and rising from ~220m asl. in the southwest to ~250 m asl. in the northeast.

The bedrock outcrops are quartzites and schists of the **Springbok Formation** (Bushmanland Group, Khurisberg Subgroup) (Ꝁsg) (Figure 2). These strata are very altered, ancient sediments ~1600 Ma (Ma = million years old) which were deeply buried and metamorphosed and now occur as remnant rafts of meta-sediments in the surrounding sea of molten-rock gneisses (locally the **Mesklip Gneiss**, ~1200 Ma) (Marais *et al*., 2001; De Beer, 2010). There are no fossils in these rocks.

5.2 The West Coast Group

The bedrock meta-sediments and gneisses are overlain by much younger formations deposited during the last 66 million years of the **Cenozoic Era**. The **West Coast Group** is the name proposed to encompass the various named formations comprising the Cenozoic coastal deposits between the Orange River and Elandsbaai (Roberts *et al*., 2006), of both marine and terrestrial origin (Table 2).

5.2.1 The Early Coastal Plain

The formation of the coastal plain begins with the rifting of the Gondwana supercontinent and the opening of the Atlantic Ocean in the early Cretaceous, 130-120 Ma, which was accompanied by the inception of numerous rivers draining to the new coastline. The rifted landscape was covered by wide coastal plains and deltas formed as many large rivers deposited enormous volumes of sediments eroded from the well-watered hinterland. Marine processes spread the finer sands and muds further to form the continental shelf extending seawards. Slumping at the shelf edge carried sediments downslope into deep water. Successive continental shelves built out and upwards as the underlying crust subsided. These now fill what is called the Orange Basin offshore, which includes an accumulation of Cretaceous sediments exceeding 6 km thickness off the Namaqualand coast.

The ongoing erosion by rivers bevelled the new continental edge, abetted by its uplift in response to the subsiding crust bending beneath the sediment load offshore, and the developing coastal plain, backed by a "Great Escarpment", approached its present configuration. A few kilometres thickness of Nama and Karoo formations had been stripped off, exposing the coastal bedrock of metasediments and gneisses.

TABLE 2. NAMAQUALAND COASTAL STRATIGRAPHY – THE WEST COAST GROUP.

Formation Name	Deposit type	Age
Witzand	Aeolian pale dunes & sandsheets.	Holocene, <~12 ka.
Curlew Strand, Holocene High	**Marine, 2-3 m Package.**	**Holocene, 7-4 ka.**
Swartlintjies & Swartduine	Aeolian dune plumes.	Latest Quat., <20 ka.
Hardevlei	Aeolian, semi-active surficial dunes, >100 m asl.	Latest Quat., <25 ka.
Koekenaap	Aeolian, surficial red aeolian sands.	later late Quat., 80-30 ka.
Local coastal aeolianite fms.	Aeolianites, limited pedogenesis, weak pedocrete	Mid-late Quat., ~250-80 ka.
Curlew Strand, MIS 5e, LIG.	**Marine, 4-6 m Package.**	**earliest late Quat., ~125 ka.**
Fossil Heuweltjiesveld palaeosurface on Olifantsrivier & Dorbank fms.		
Unnamed "Dorbank" fms.	Aeolian, reddened, semi-lithified.	later mid-Quat., ~400-140 ka.
Curlew Strand, MIS 11.	**Marine, 8-12 m Package.**	**mid Quat., ~400 ka.**
Olifantsrivier	Aeolianite, colluvia, pedocrete.	early-mid Quat., ~2-0.4 Ma.
Graauw Duinen Member 2	Aeolianite, colluvia, pedocrete.	latest Plio-early Quat.
Hondeklipbaai	**Marine, 30 m Package, LPWP.**	**late Pliocene, ~3 Ma.**
Graauw Duinen Member 1	Aeolianite, colluvia, pedocrete.	mid Pliocene.
Avontuur	**Marine, 50 m Package, EPWP.**	**early Pliocene, ~5 Ma.**
Unnamed	Aeolianites, weathered.	later Miocene (14-5 Ma)
Kleinzee	**Marine, 90 m Package, MMCO.**	**mid Miocene, ~16 Ma.**
Unnamed	Aeolianites, leached, faulted.	Oligocene
Koingnaas	Fluvial, kaolinized gravels, sands, plant fossils.	late Eocene
De Toren	Silcreted colluvial palaeosurfaces 200-400 m asl.	Paleocene - Eocene
MMCO – Mid Miocene Climatic Optimum. EPWP – Early Pliocene Warm Period. LPWP – Late Pliocene Warm Period. MIS – Marine Isotope Stage.		

Ongoing erosion has removed nearly all traces of early Cretaceous deposits from the present-day West Coast coastal pain. A rare instance dating from the early Cretaceous rifting is preserved just north of the Buffelsrivier mouth and is evidently the surviving, deepest part of a fault-bounded lake. Discovered by drilling, the lacustrine deposits contain fossil pollen of the early Cretaceous flora (Molyneux, in Rogers *et al*., 1990). Rounded cobbles of petrified, early Cretaceous *Podocarpoxylon* woods are found in the onshore marine gravels of the Quaternary raised beaches near Kleinsee and south of Port Nolloth (Bamford & Corbett, 1995), reworked successively from now-vanished Cretaceous fluvial deposits of the early coastal plain.

A feature of the older erosion surfaces of the coastal plain, preserved in places on the interfluves between the existing ephemeral rivers of Namaqualand, is the presence of pallid, kaolinitic, white "china clay" weathering profiles and associated silcretes, which developed during the humid tropical climates of the early Cenozoic. There are many buried, old river palaeochannels incised into the bedrock between the existing drainage lines. The deposits in these channels have also been kaolinized and silcrete has also formed in places within the waterlogged channels. It is possible that later Cretaceous fluvial deposits once filled the palaeochannels, but it seems that the palaeochannels underwent cycles of infilling and flushing out with fluctuations of sea level during the early Cenozoic, until the deposits finally occupying most of the palaeochannels, namely the **Koingnaas Formation**, are much younger. However, due to the pervasive kaolinitic weathering of the palaeochannel deposits it is possible that remnants of the older, late Cretaceous and/or early Cenozoic deposits may be disguised in places in the bases of the channels.

The **Koingnaas Formation** (De Beer, 2010) deposits in the palaeochannels consist of subangular to subrounded vein-quartz conglomerates, locally rich in diamonds, overlain by beds of clayey sand, clay and carbonaceous material containing plant fossils, in a pale matrix of kaolinite (Molyneux, in Rogers *et al*., 1990), with yellow and red ochreous staining in places. The fossil pollen has provided evidence of the vegetation type present and the age of the Koingnaas Formation. Yellowwood forest with auracaria conifers, ironwoods and palms dominated the West Coast. Fossil wood identified as tropical African mahogany has been found.

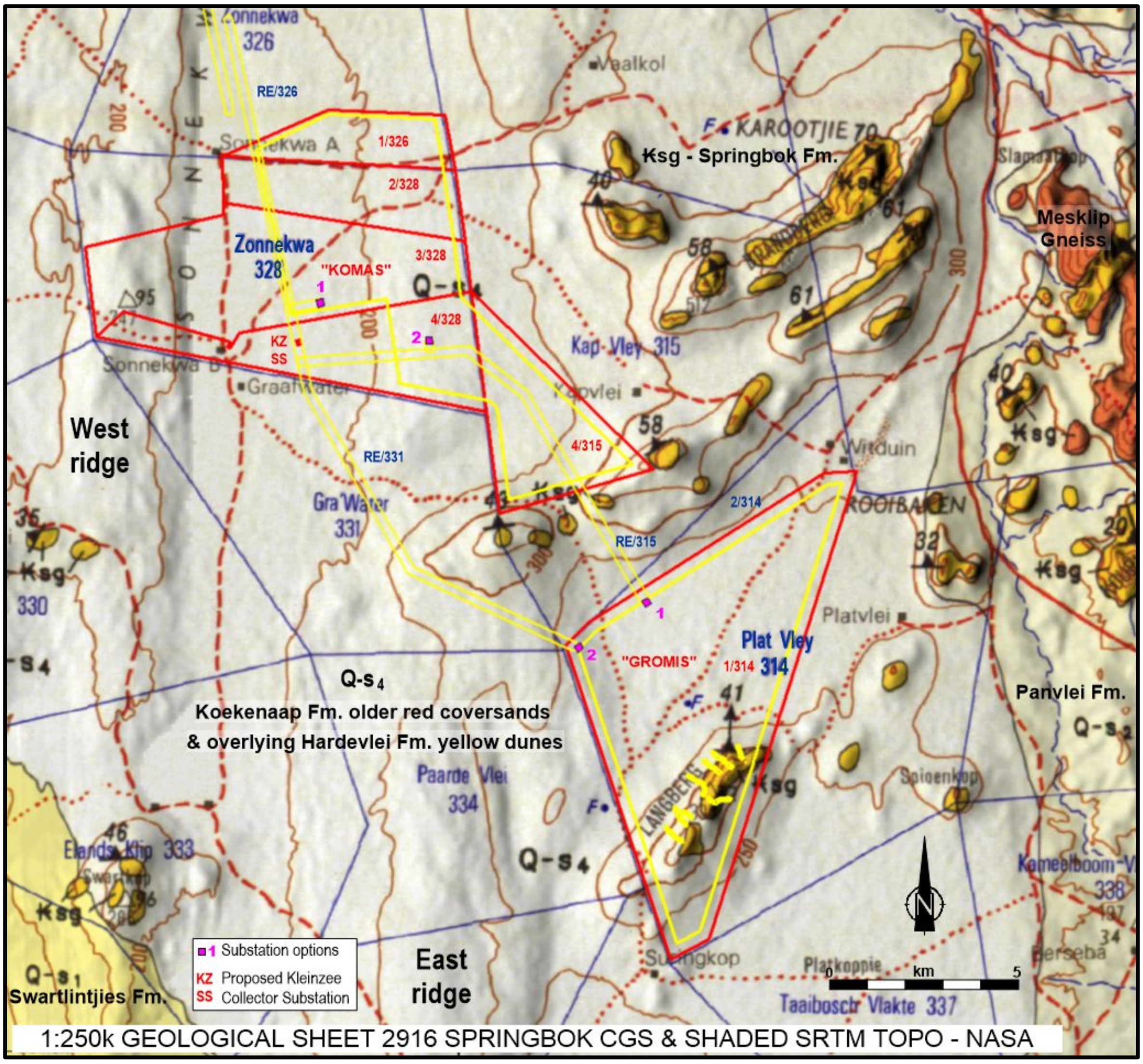


Figure 2. Surface geology of the proposed Gromis and Komas WEF development areas. Property boundaries in red and proposed development areas and power line routings shown in yellow.[1]

The presence of early forms of pollen of the Asteraceae (daisy family) indicates that the age of Koingnaas Formation is late Eocene (Figure 3), with the aggradation of fluvial deposits in the palaeochannels likely correlating with times of rising sea levels between 44-34 Ma. Notably, the Koingnaas pollen assemblage, with many extinct types of uncertain affinity and no analogues elsewhere, indicates that the uniqueness of the Cape Floristic Region is rooted in "deep time" (De Villiers & Cadman, 2002). The Koingnaas Formation deposits are remainders of a fossil landscape when the wooded Namaqualand coast approximately resembled the forests of the South Coast.

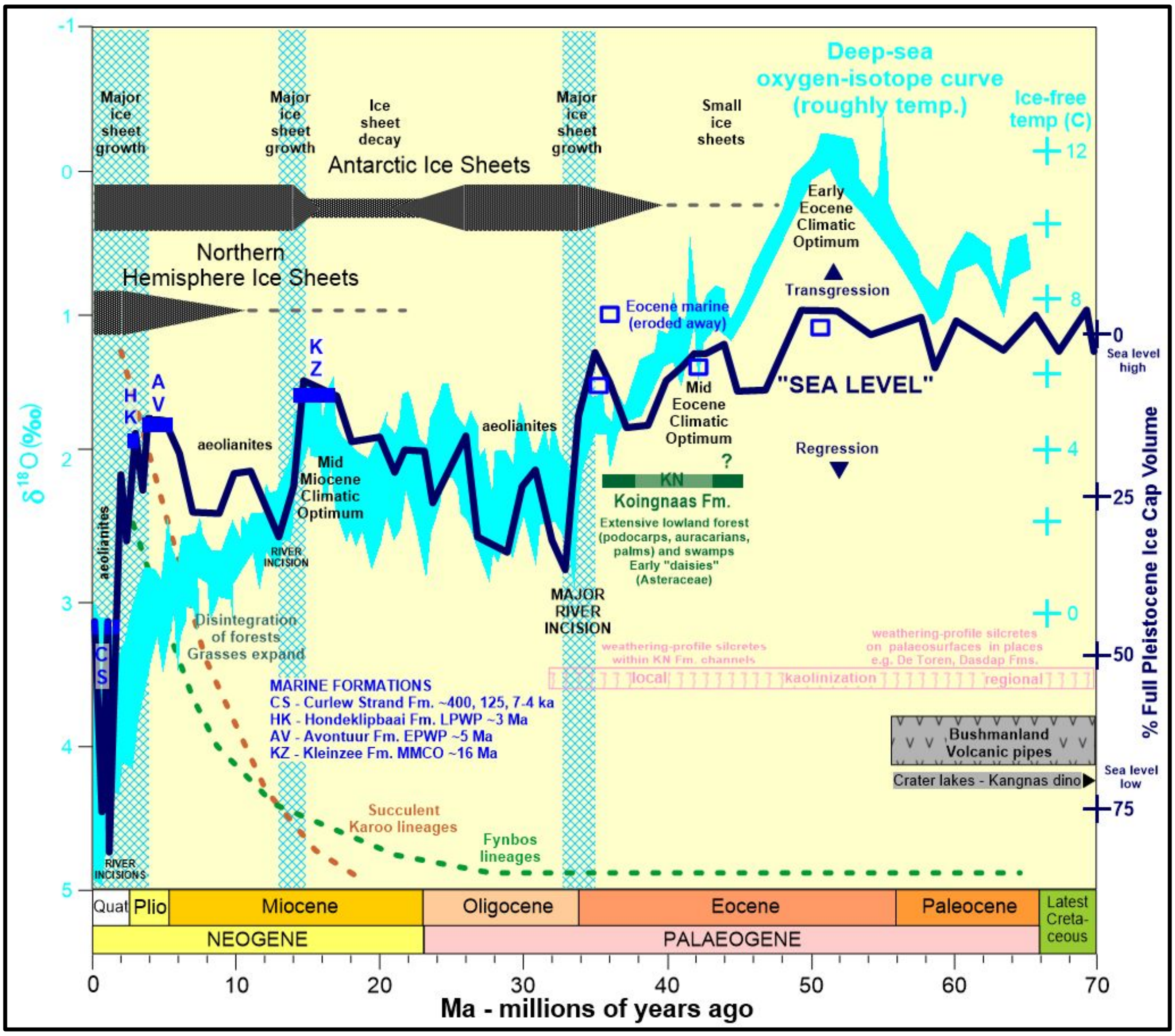
Figure 3: The Cenozoic Era (66 Ma to present) showing global palaeoclimate proxies, aspects of regional vegetation history and the context of marine formations of the West Coast Group, Alexander Bay Subgroup.

[1]The map shows the previous layout and has not been updated as adjustments to the layout of the turbines and infrastructure do not affect the results of the assessment and the same mitigation measures would be applicable in the area at large regardless of the exact layout.

Cyan curve - history of deep-ocean temperatures, adapted from Zachos *et al*. (2008). **Blue curve** is an estimate of global ice volumes, adapted from Lear *et al*. (2000). Global ice volumes roughly indicate sea-level history caused by the subtraction from the sea of water as land-ice. The expansion of Fynbos and Karoo floras is adapted from Verboom *et al*. (2009). MMCO – Mid Miocene Climatic Optimum. EPWP – Early Pliocene Warm Period. LPWM - Late Pliocene Warm Period.

5.2.2 The Marine Formations

The early coastal plain would have been transgressed by the sea during high sea-levels associated



with peak global warming intervals during the Paleocene and Eocene (Figure 3), but no deposits of this earlier marine history are known to remain along Namaqualand. Diamondiferous Eocene marine remnants are preserved on the southern Namibian coast and must also have been present on the Namaqualand coastal plain, but were evidently later flushed off into rivers during the late Eocene and Oligocene.

Towards the end of the Eocene and during the Oligocene the global climate underwent major cooling and polar ice built up on the Antarctic continent, lowering sea level significantly (Figure 3), while drier climatic conditions likely pertained along the West Coast. This "**Oligocene Regression**" is thought to have had an impact on the coastal plain by the incision and entrenchment of the present-day river courses and further erosion back into the Escarpment. Towards the end of the Oligocene the cooler global climate began to ameliorate and with large fluctuations this warming trend continued through the early Miocene and peaked in the middle Miocene during the warm **Mid-Miocene Climatic Optimum** ~17-14 Ma (Figure 3). Melting of the Antarctic ice cap raised sea level and the outer part of the coastal plain was inundated by the sea up to an elevation which is now ~90 m asl. When sea level receded again the marine **Kleinzee**

Formation was deposited on the inner, high part of the coastal bevel and extends seawards from ~90 m asl. (also called the 90 m Package).

The previous Miocene marine beds were eroded during rising sea-level of the **Early Pliocene Warm Period** and the **Avontuur Formation** (the 50 m Package) was deposited 5-4 Ma as sea-level receded from the transgression maximum of about 50 m asl. and the shoreline prograded seawards (Figure 4).

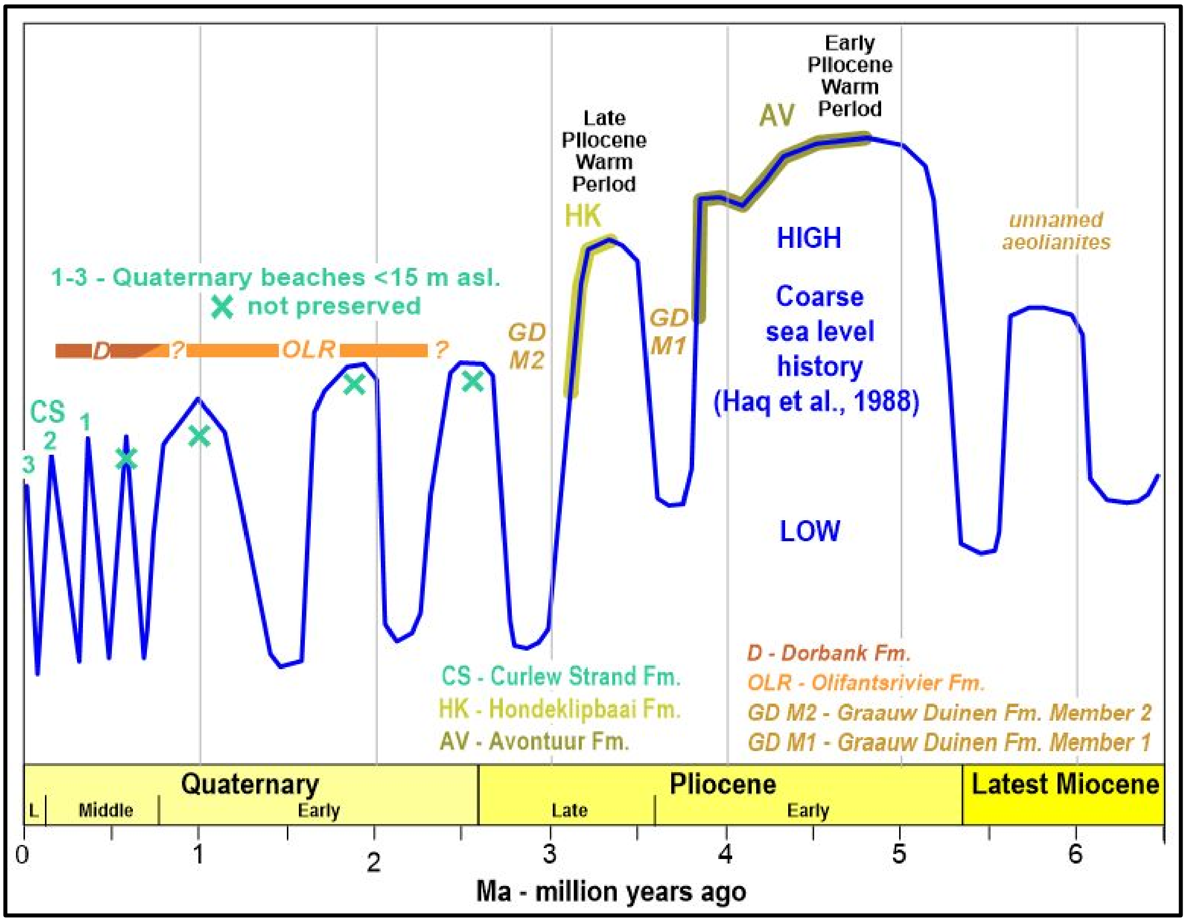


Figure 4. Context of latest Miocene, Pliocene and Quaternary marine and aeolian formations correlated with coarse-scale sea-level history based on major margin unconformities.

The Avontuur Formation in turn was eroded by yet another rising sea-level associated with the **Late Pliocene Warm Period** 3.3-3.0 Ma (Figure 4). The **Hondeklipbaai Formation** or 30 m Package was deposited as sea level declined from a high of about 30-33 m asl. and a substantial, prograded marine formation built out seawards. This formation, up to a few km wide, underlies the outer part of the coastal plains of the West Coast. The actual sea levels were not at the absolute elevations mentioned above – the ancient palaeoshorelines have attained their present elevations due to uplift of the continental margin. Fossil shells are found in places in these Miocene and Pliocene marine formations and each contains warm-water species and also important extinct fossil shell species which are characteristic of that formation and which facilitate correlation of formations over wide regions.

Close to the seaside, the Hondeklipbaai Formation is eroded and overlain by the younger, Quaternary "raised beaches" that extend up to about 12-15 m asl. The name **Curlew Strand Formation** has been proposed for this composite of raised beaches, equivalent to the Velddrif Formation of the SW Cape Coast. It comprises the **8 - 12 m Package** dating to ~400 ka (ka = thousand years ago) during Marine Isotope Stage 11 (MIS 11), the **4 - 6 m Package** of the Last Interglacial (LIG) ~125 ka and the **2 - 3 m Package** (mid-Holocene High, 6-4 ka) (Figure 4, CS 1, 2, 3). The fossil shells in these “raised beaches” are predominantly the cold-water fauna of modern times.

5.2.3 The Aeolian Formations

A variety of terrestrial deposits also make up the coastal plain of Namaqualand. These are predominantly extensive aeolian dune and sandsheet deposits that overlie the eroded tops of the marine sequences near the coast, and as dune plumes extending inland. A glance at the satellite images of the coast show that the dune plumes of various ages occur in specific areas and are linked to topography, sea-level oscillations, the changing locations of sandy beaches and fluvial sediment inputs. Similarly, the deeper-time aeolian record is expected to comprise buried dune fields, dune plumes and sand sheets that accumulated at different times in various areas of the coastal plain. More locally there are colluvial (sheetwash) and ephemeral stream deposits associated with nearby hillslopes; these dominate the thinner cover of the hills of the higher, inner coastal plain. Formed within the terrestrial sequences are pedocretes and palaeosols of a variety of types, compositions and degrees of development which mark times of surface stability and relate to times of reduced aeolian activity (less windy) and/or more humid climatic intervals.

Our embryonic knowledge of the stratigraphic context of these older, buried aeolianite formations comes from the huge mine pits created by diamond and heavy-mineral mining, but these observations are mainly confined to the lower coastal plain (<~100 m asl.) where the dated marine formations underlie or are interbedded with the aeolian formations. The major pedocretes present in the mining pits are regional in extent and will also occur within the unexposed and unknown aeolian sequences of the higher coastal plain, and should be of stratigraphic utility for correlation.

The older aeolian formations, such as the **Graauw Duinen** and **Olifantsrivier** formations (Table 2), which are exposed in mine pits and eroding cliffs close to the coast, are rarely exposed on the higher coastal plain inland from ~100 m asl., except as outcrops of their cappings of well-developed pale pedocretes (calcrete, sepiocrete) in places. For the most part, these older formations are buried beneath more aeolianites of varying ages and thicknesses, from several metres thick up to ~15 m thick, which have been transformed by pedogenesis into yellow-brown to red-brown, semi-cemented beds colloquially called “dorbank”. For practical purposes these “dorbank” units are lumped together and referred to as the **Dorbank Formation**.

The **Dorbank Formation** is typically a stack of successive sand sheet and dune beds forming units 0.5 m to ~2 m thick, with slightly differing hues of the neoformed pedogenic clays. The dorbank is quite hard and incipiently to variously cemented, but notably, this formation lacks the development of distinct, laterally continuous, pale pedocrete horizons, other marked, post-depositional features and generally also lacks an evolved pedocrete capping. The Dorbank Formation is widespread along the Namaqualand coast where it occupies a spatio-temporal context as the youngest consolidated aeolianite beneath weakly-compacted to loose surface sands. Notably, Middle Stone Age (MSA) artefacts occur within its upper portion and on its top surface, these suggesting that the age is in the later part of the middle Quaternary, younger than about 400 ka (Figure 6). Dating of the overlying Koekenaap Fm. surficial sands (see below), together with some few dates from the top of the Dorbank Fm. farther south, indicates that the Dorbank Fm. is older than ~130 ka, pre-dating the Last Interglacial.

Overlying the hard surfaces on the tops of the **Dorbank Formation** units are the poorly-consolidated to loose, surficial sandsheets and dunes of the modern landscape. This more recent aeolian history is expressed in features of the topography, dune morphologies, sand colours and vegetation patterns and the distribution of these features in the landscape shows the roles of the sandy beaches and riverbeds as sand sources for southerly wind. The inland surficial sands are not differentiated on the Springbok geological map, being mapped only as Q-s_4 (Figure 2) and described as "*semi-consolidated piedmont deposits, red sand*". These surficial sands may be elaborated by extrapolating the formations recognised farther south (De Beer (2010) and pers. obs.). In the area of interest these are mainly the **Koekenaap** (Qkk) and **Hardevlei** (Qh) formations (Table 2) (Figure 5).

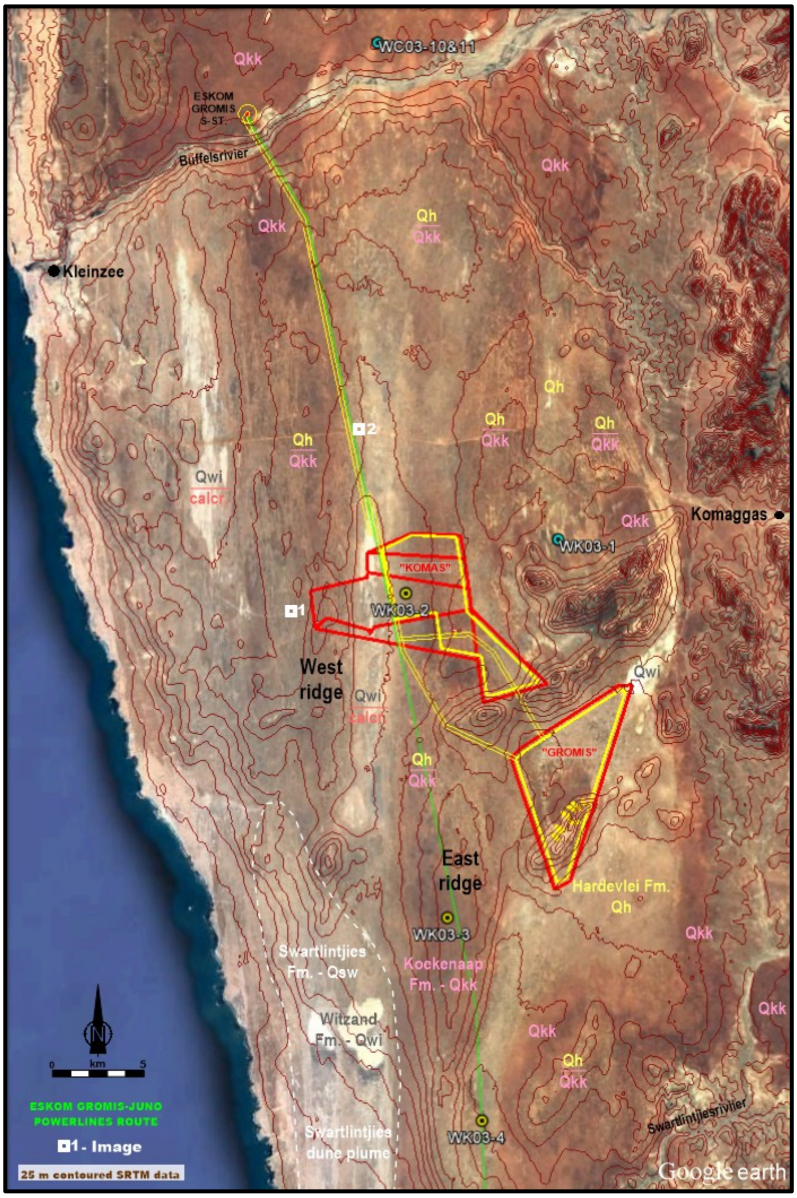
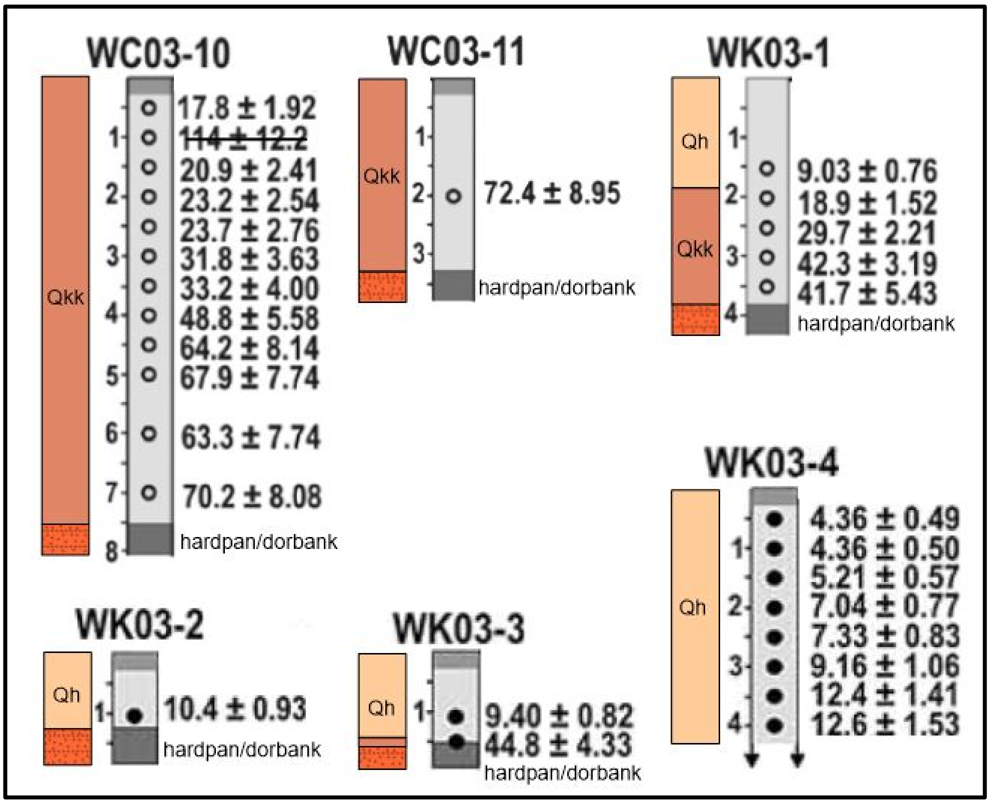


Figure 5. Overview of surficial sand formations in the Swartlintjies-Buffels aeolian compartment.[1]

[1] The map shows the previous layout and has not been updated as adjustments to the layout of the turbines and infrastructure do not affect the results of the assessment and the same mitigation measures would be applicable in the area at large regardless of the exact layout.

Koekenaap Formation (Qkk) (Roberts *et al.*, 2006; De Beer, 2010) refers to the variously-reddened, unconsolidated coversands and low, degraded dunes which mantle much of the surface of the coastal plain, overlying the hard surface of the Dorbank Formation. Where thicker, subunits can be distinguished by subtle variations in hue and grain adhesion. The red sands are underlain by scatters of MSA material on top of the palaeosurface formed on the "Dorbank" or older aeolian formations. Results of Optically-Stimulated-Luminescence (OSL) dating of some reddened coversands (Chase & Thomas, 2006, 2007) produced late Quaternary ages between ~80 ka and ~20 ka (Figure 6) and suggest phases of accumulation which differ between areas. Sand sources include the coast and the reworking of older sands, while the older red sands on the higher, inner coastal plain have apparently been sourced from the local rivers. The typical vegetation types are



Namaqualand Strandveld and Namaqualand Heuweltjie Strandveld.

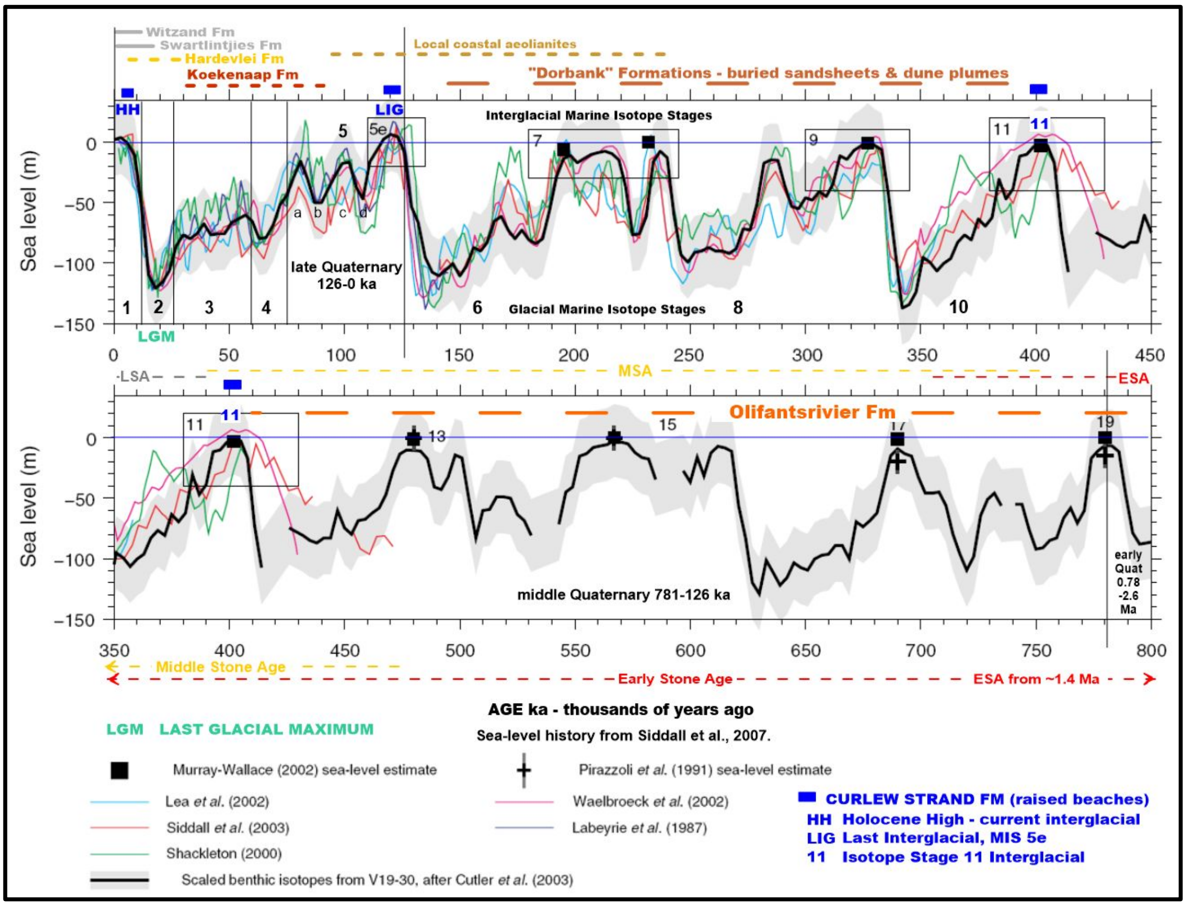
Figure 6. Optically-Stimulated-Luminescence -dated sections of the surficial sands of the Koekenaap (Qkk) and Hardevlei (Qh) formations. Adapted from Chase & Thomas, 2006, 2007. Core site locations indicated in Figure 5.

Subsequent aeolian activity is manifested in the yellow dunes of the **Hardevlei Formation** (Qh) (De Beer, 2010) which encompasses fields of low, pale-yellow dunes of varied morphology overlying the Koekenaap-type red sands or the local Dorbank Formation., and which are developed inland from the coast on the higher, inner parts of the coastal plain. Dune types include both parallel, longitudinal sand ridges formed by the northward migration of vegetation-impeded, parabolic, "hairpin" dunes, and transverse, barchanoid (crescentic) dunes. In southern Namaqualand both morphologies are combined to form reticulate dune fields formed by directionally-variable winds, but in this area longitudinal dune morphologies dominate due to the predominance of the southerly wind. Dating by the OSL technique indicates ages generally less than ~20 ka (Chase & Thomas, 2006, 2007) (Figure 6).

The name **Swartlintjies Formation** (Qsw) is proposed for the large, pale plumes of semi-stabilized parabolic dunes that extend far inland northwards from the beaches north of the main rivers (Roberts *et al.*, 2006; De Beer, 2010) and which are the latest large-volume additions to the coastal plain. The Swartlintjies dune plume (Figure 5, Swartlintjies Fm.) is the type example. The plume sands were blown by south winds from the beaches now submerged by rising sea levels since the Last Ice Age maximum ~20 ka (Figure 7, LGM), when the shoreline was ~120 m below present (Tankard & Rogers, 1978). Similarly, large dune plumes blew inland from the coast in the deeper past and are evident as broad low ridges in the landscape.

The **Witzand Formation** (Qwi) accommodates sand and shell fragments blown from sandy beaches during the Holocene, in the form of partly-vegetated dune cordons backing the beach and the attached small dune plumes transgressing inland. Also included in the Witzand Formation are fields of white, mobile dunes that occur inland, where older dune sands have been remobilized, such as at the type locality on the farm Witzand, near Atlantis in the South Western Cape.

The **Panvlei Formation** (Figure 2) refers to pedocreted regolith, colluvium and old aeolianite mantling the slopes of the foothills along the inner margin of the coastal plain. The overlying thin,

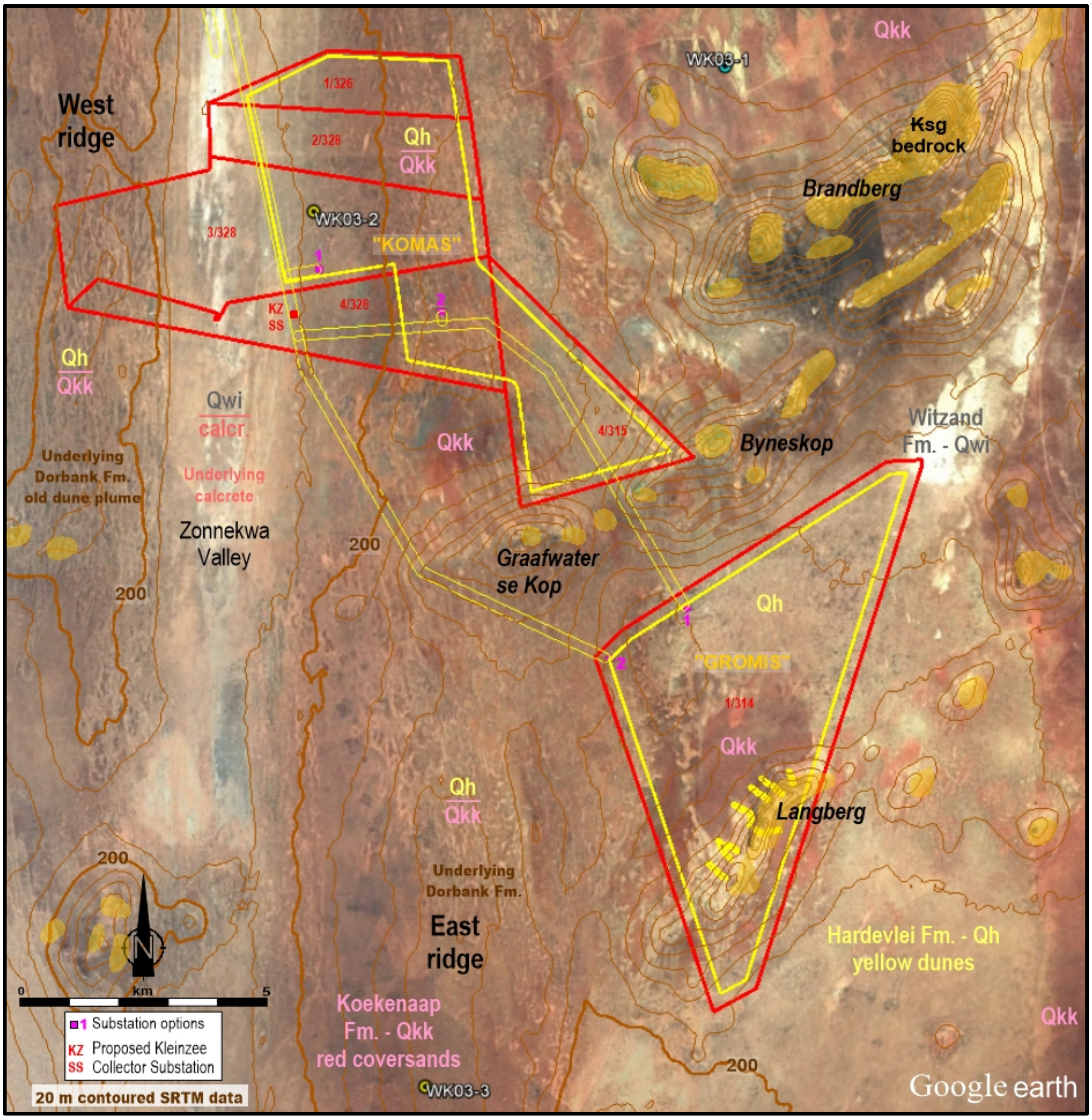


sandy soils have developed the clumped vegetation pattern of Namaqualand Heuweltjieveld.

Figure 7. Sea-level history (from Siddall *et al.*, 2007) and the age ranges of middle and late Quaternary formations of Namaqualand.

6 ASPECTS OF THE LOCAL GEOLOGY OF THE PROJECT AREA

Considerable thicknesses of deposits have accumulated in the valleys between the bedrock hills and are thickest in the ancient palaeochannels incised into the bedrock. The palaeochannel draining to the southwest beneath the proposed Gromis WEF development area may contain deposits of the **Koingnaas Formation**., or possibly older fluvial deposits, and potentially includes overlying, younger fluvial deposits of Miocene and/or Pliocene age. There are less obvious palaeochannels beneath the proposed Komas WEF development area. Excavation for turbine foundations during the construction phase of both the Gromis and Komas WEFs are not expected



to intersect these deeper fluvial formations. Marine deposits are not expected to occur beneath either of the proposed WEFs.

Figure 8. Surficial geology and features of the Project Areas.[1]

Notable large-scale aeolian depositional features ("fossil" dune plumes) are noted beneath thin cover of the surficial sands in the West Ridge and East Ridge of the general project area. These plumes largely comprise of the Dorbank Formation (Figures 5 & 8). A low-lying, pale-hued, shallow valley separates the aeolian ridges. The influence of the quartzite bedrock ridges in topographic steering of the wind is evident in the disposition of the dunes about them.

A shallow pit in the West Ridge (Figure 5, location 1) shows the aeolian unit at the top of the compact Dorbank Formation (Figure 9). Another pit in the ridge flank (Figure 5, location 2) shows a similar unit with steep dune crossbedding (Figure 10). The unit has been subjected to pedogenesis, with the formation of neoformed interstitial clay and typically lacks distinct pedocrete

[1] The map shows the previous layout and has not been updated as adjustments to the layout of the turbines and infrastructure do not affect the results of the assessment and the same mitigation measures would be applicable in the area at large regardless of the exact layout.

horizons. The relatively soft, eroding exposures, indicate that the unit is a relatively young member of the Dorbank Formation, of later mid-Quaternary age (Figure 7). For instance, at the youngest it is of Marine Isotope Stage (MIS) 6 to MIS 5/6 age. It is on trend with the Swartlintjies dune plume and appears to be an earlier plume that extended considerably farther north (Figure 5). The East Ridge is assumed to be an older Dorbank Formation fossil dune-plume.

Most of the surficial cover is typified by red sands of the **Koekenaap Fm**., with clumped vegetation dot patterning visible in the interdune areas between the overlying yellow dunes of the **Hardevlei Fm**. which are generally distributed in the landscape. The proposed Komas WEF development area has this typical surficial cover. In the broad valley between the Dorbank Fm. ridges, herein called the Zonnekwa Valley, are pale sands which are referred to the Witzand Fm. The valley is evidently a sand transport corridor, from the "dusting" of pale sands emanating from it and extending across the north-western part of the proposed Komas WEF. The valley is apparently closely underlain by a pale calcrete pedocrete beneath which the older aeolian formations are expected, equivalent to the **Olifantsrivier** or **Graauw Duinen** formations. In the southeast region of the proposed Komas WEF development area; another pale "dusting" of recent sand mobility evidently relates to the "wind gap" between Byneskop and Graafwater se Kop.

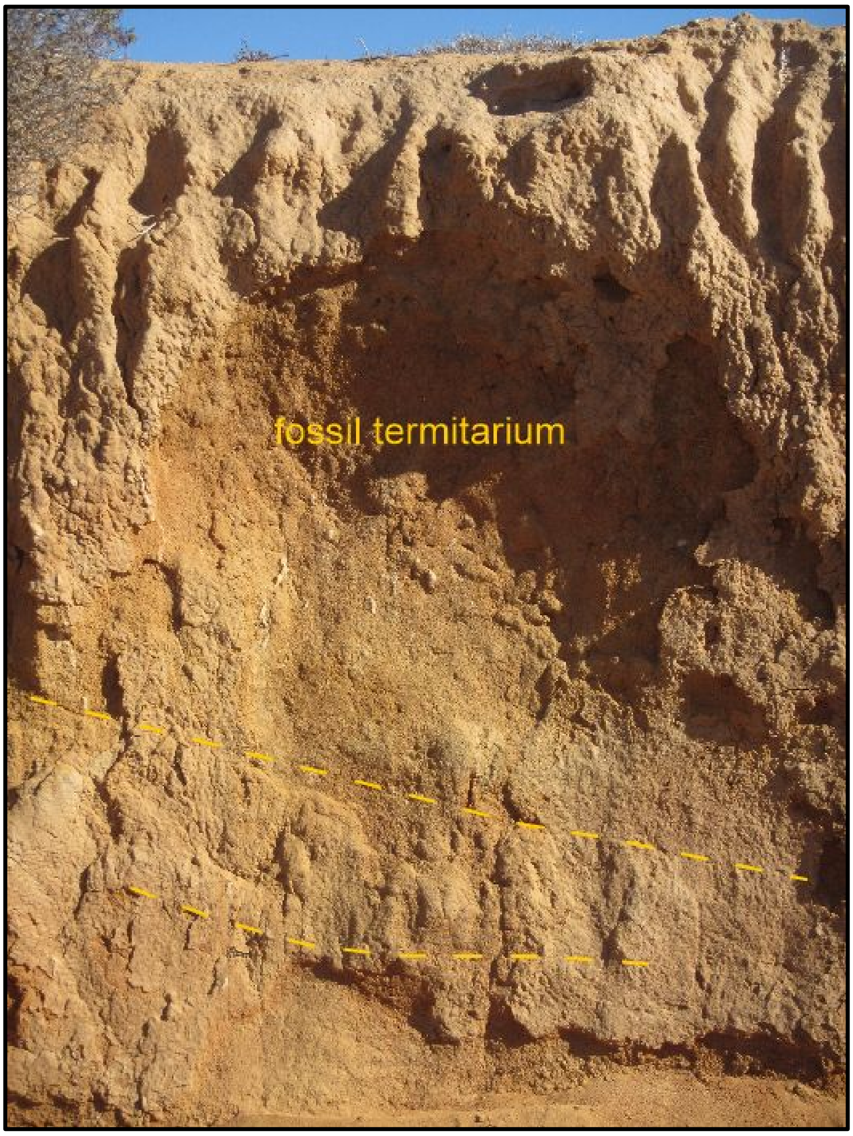
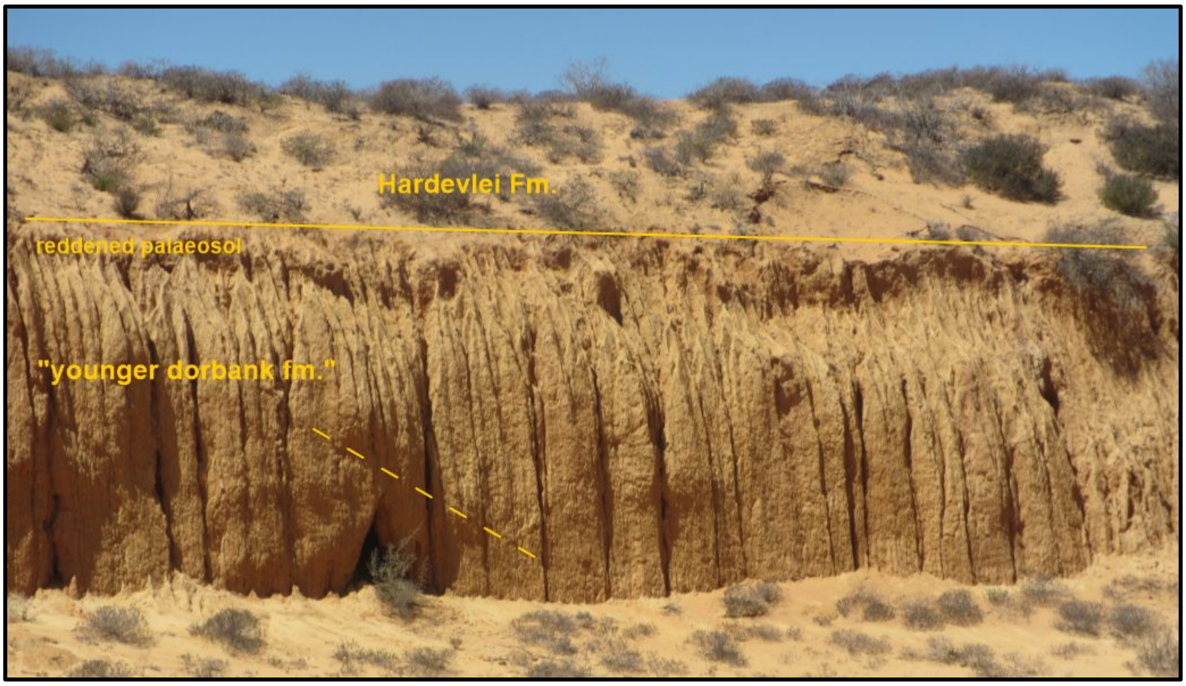


Figure 9. The uppermost Dorbank Formation unit at location 1 in Fig. 5. Dashed lines trace relict dune lower-foreset crossbedding lapping tangentially onto basal wind-ripple laminated interval. Image courtesy of J. Orton.

The surficial sands in the proposed Gromis WEF development area are spatially differentiated, with Koekenaap Fm. patterned red sands surrounding the Langberg ridge, particularly on the northern lee side due apparently to a "wind shadow" effect similar to that seen in the lee of the Brandberg ridge, and where the formation of Hardevlei Fm. dunes has been limited. The northern part of the proposed Gromis WEF development area is covered by Hardevlei Fm. sands which is part of a larger area of Hardevlei sands transport extending from the south along the inner part of the coastal plain. A white patch of mobile dunes to the northeast, referred to the Witzand Fm., corresponds with the zone of flow acceleration around the Brandberg ridge.

A dark reddish patch surrounding a slight hill with outcropping bedrock was noted north of the proposed development areas of the Gromis and Komas WEFs, along the proposed power line route (Figure 5). The slopes are mantled by old, reddened colluvia that have been lithified to hard pedocrete. The dark red heuweltjiesveld which occurs in the general area is evidently a patch of older Koekenaap Fm. coversands thinly covering the bedrock.

Dark red-brown surficial cover attributable to the Koekenaap Fm. dominates immediately north of the Buffelsrivier (Figure 5). Here 7 metres of red sand accumulated between ~70 to ~20 ka (WC03-10, Figure 6). This illustrates the role of the river as an aeolian compartment boundary, supplying sand for northward transport and impeding sand encroachment from the south by its



periodic removal.

Figure 10. The upper Dorbank Formation. unit at location 2 in Fig. 5. Dashed line indicates relict, steep aeolian foreset crossbedding. Unconsolidated dune sand of the Hardevlei Formation overlies a thin palaeosol. Image courtesy of J. Orton.

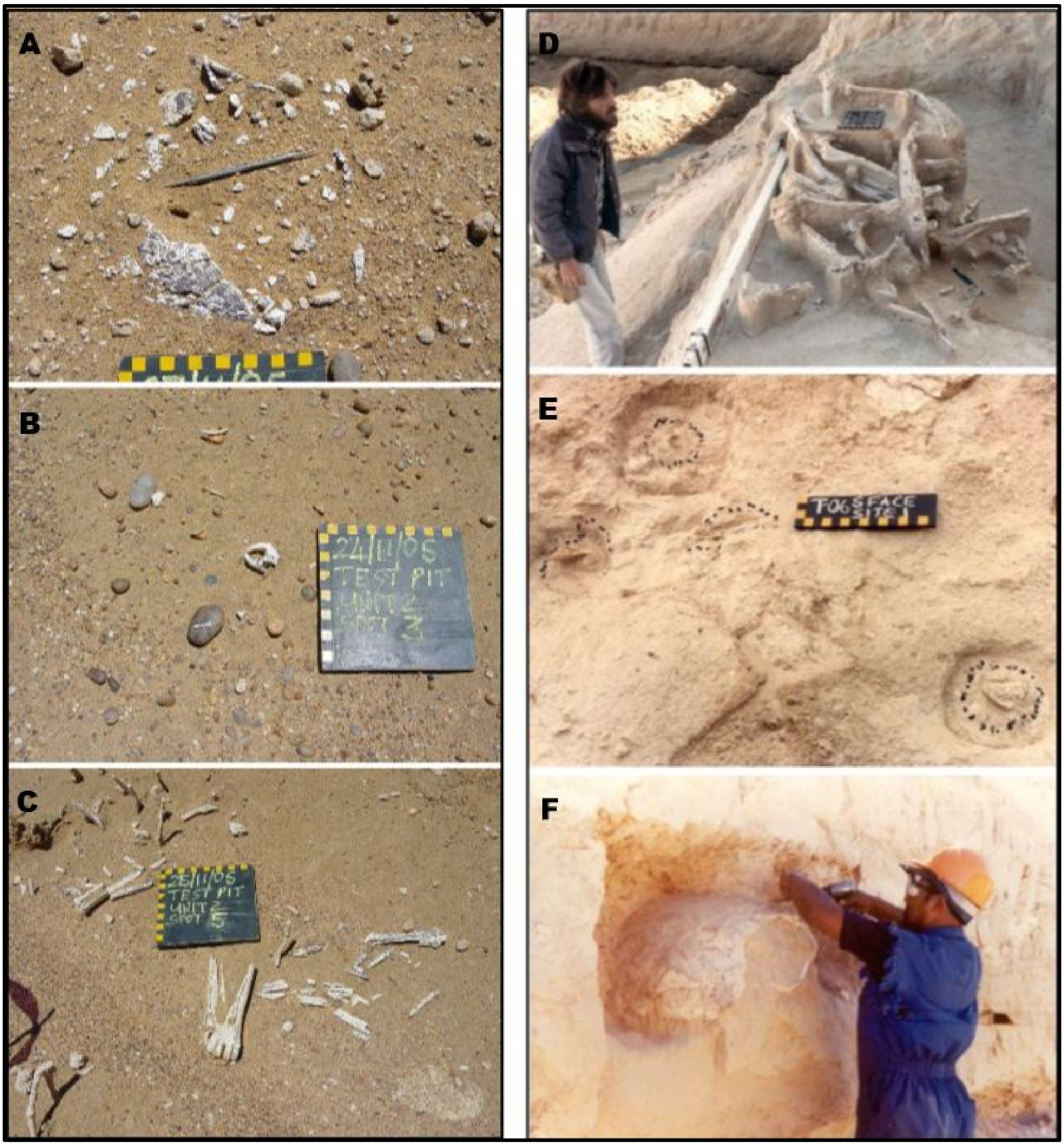
7 AFFECTED FORMATIONS

The thickness of the surficial sand formations is very variable due to the Hardevlei Fm. dune accumulations and in places the underlying Dorbank Fm. is at very shallow depth (WK03-2, WK03-3, Figure 6). The shallow trenches for cabling and building foundations will primarily be made in the surficial sands of the Hardevlei and Koekenaap formations, but it may be expected that the surface and upper part of the Dorbank Fm. will be intersected in shallow excavations in places. The deeper excavations for the wind turbine foundations and the pylon foundations will penetrate the underlying Dorbank Fm. In the north-western parts of the proposed Komas WEF development area the Dorbank Formation is thin and is underlain by the calcrete exposed in the adjacent

Zonnekwa Valley and which has formed in an older early Quaternary or Pliocene aeolian formation. The calcrete and old aeolianite will be intersected by the turbine and pylon foundation excavations situated along the Zonnekwa Valley.

8 EXPECTED PALAEONTOLOGY

The fossil bones that have been found hitherto in the aeolianites of Namaqualand attest to the fossil potential that will be delivered by the continuation of systematic searches for these sparse remains. Fossil material most commonly seen is the ambient fossil content of dune sands: land snails, tortoise shells and mole bones (Figures 11A, B; 12A). Other small bones occur very sparsely such as bird and small mammal bones. The fossil content is more abundant in association with palaeosurfaces and their soils (palaeosols), formed during periods of dune stabilisation and which define aeolian packages and larger formations. Importantly, the sparse

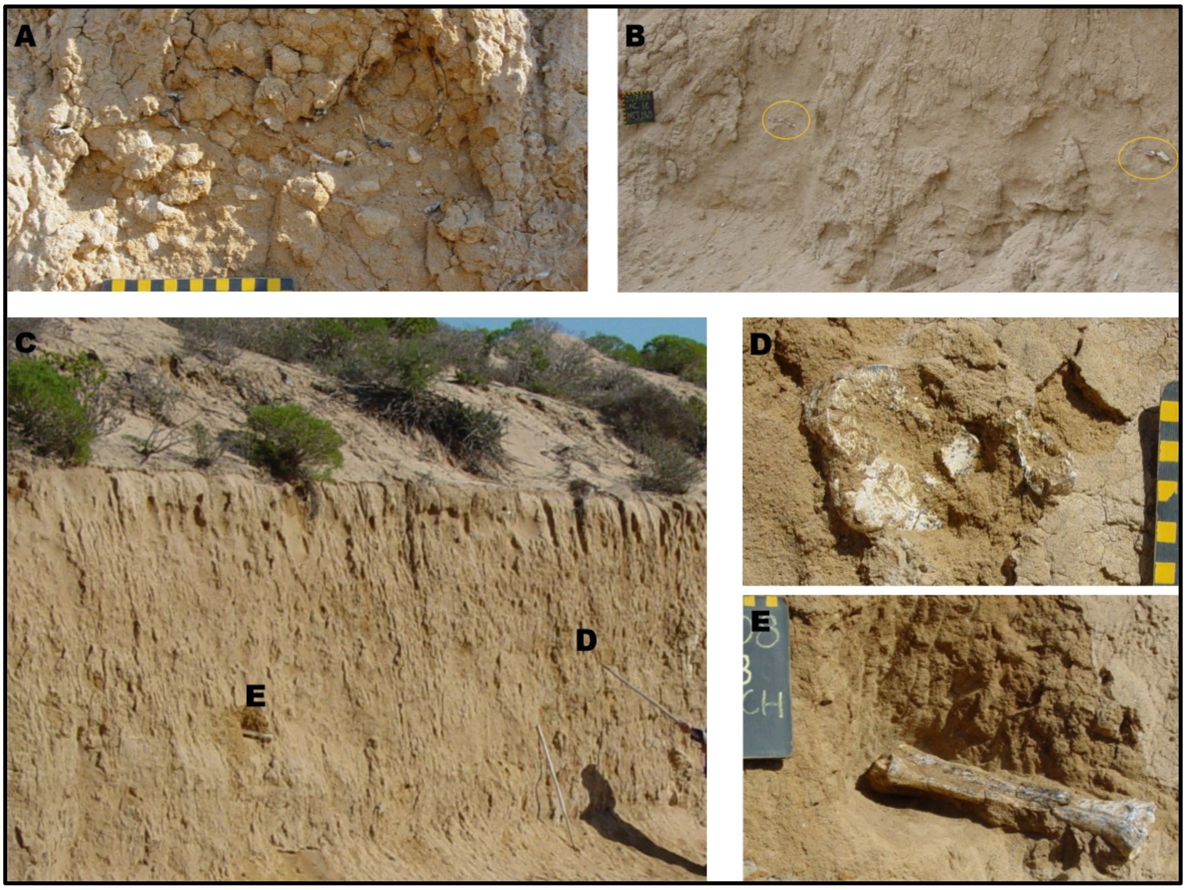


bones of larger animals (*e.g.* antelopes, zebra, rhinos) are more persistently present along palaeosurfaces which separate the major aeolianite formations where they are enclosed in palaeosols and pedocretes, and also occur on cryptic palaeosurfaces within formations (Figure 12). Rare large caches of bones are due to the bone-collecting behaviour of hyaenas and occur in probable aardvark burrows that were subsequently occupied by hyaenas (Figure 11D).

Figure 11. Examples of in situ fossil finds in aeolianites. A & B – ambient fossils in aeolianites, tortoise (A) and rodent (B). C – bovid (antelope) limb bone. D – hyaena bone stash in a burrow. E – poorly visible bones in pedocrete. F – giant tortoise.

Although fossil bones are very sparse in aeolian Dorbank formations and overlying coversands and dunes, they are of high scientific value and important for palaeoclimatic, palaeobiological and biostratigraphic studies. The fossil material in these deposits is a sample of the middle and late Quaternary fauna of the Namaqualand coast. For example, fossil bones in aeolianite near the Swartlintjiesrivier were associated with Early Stone Age (ESA) artefacts and include large species (elephant, sivathere, zebra). *Sivatherium maurusium* was a large, heavily-built short-necked giraffid common in Africa between ~5.0 to ~0.4 Ma. In addition, small species were collected (hare, squirrel, moles, snakes). The estimated age is mid-Quaternary and the large mammals indicate that the coast was better watered than the present-day (Pickford & Senut, 1997).

Another example is a late Quaternary fauna obtained from calcareous interdune deposits exposed between the dunes of the Swartlintjies Formation. The presence of frogs indicates a damp environment. Larger species include ostrich, zebra and steenbok and oddly, giraffe, a tree browser. A variety of small rodent taxa occurred. Other than the giraffe, the fauna is essentially modern. The giraffe suggests that woodland still occurred in Namaqualand as recently as the late Quaternary, probably related to riverine settings and wetter conditions associated with the Last Ice



Age climate (Pickford & Senut, 1997), or wet spells during the deglaciation.

Figure 12. Fossil bones scattered on cryptic palaeosurfaces in Dorbank Formation deposits.

9 ANTICIPATED IMPACTS

Impacts to palaeontological resources would occur as a result of earthmoving and excavations for roads, foundations and electrical cables. Fossils can be moved from their original contexts and can be damaged or destroyed. The main earthworks involved are the excavations for the turbine foundations which have an approximate diameter of up to 25 m and will typically be approximately 3 m deep, however the majority of the site is expected to have hard excavation difficulties and therefore shallow foundation solutions with an anchoring system will likely be required. The Gromis WEF is proposed to comprise of 33 turbines and the Komas WEF is proposed to comprise of 50 turbines. There are a considerable number of them distributed over and "sampling" a wide area. Therefore, in spite of the overall low fossil potential, there is a distinct possibility that fossil bones may be exposed in some of the excavations.

In the Hardevlei and Koekenaap formations the fossil bone and marine shell material that may occur is likely to be in an archaeological context. Both artefacts and fossil bones are most often found on the compact palaeosurface of the Dorbank Fm. beneath the surficial sands. These occurrences usually only come to light when large areas of the surficial sands have been mostly mined away, but leaving some residual sands that are subsequently blown away, exposing the fossil material on top of the Dorbank Fm. The fossils and artefacts are sparse in the Hardevlei and Koekenaap formations, particularly inland from the coast. The fossil bone material would be of late Quaternary age and comprised mainly of extant species (modern fauna), but could include species that did not historically occur in the region. **The palaeontological sensitivity of the surficial sand formations is therefore considered to be of LOW significance** (Appendix 3).

The fossil bone finds in the Dorbank Formation are generally the scattered, disarticulated and sometimes fragmented larger limb bones of antelopes and zebra, but the Swartlintjies occurrence associated with ESA artefacts mentioned above shows that significant finds may occur. Most finds have been at lower elevations in diamond-mine pits and little is known of this formation and its fossils at higher elevations and in this region of the coastal plain. Where the Dorbank Fm. laps onto the slopes of the quartzite ridges it is expected that colluvium and ephemeral runoff deposits are interbedded with the windblown sands. The fossil record in colluvia is very sparse and such deposits are of low fossil bone potential. In the arid terrain the bones of animals remain exposed and have poor preservation potential due to weathering and bioerosion (gnawing) by rodents and insects. Notwithstanding, it is still possible that fossil material may occur. Hills provide vantage of the landscape for carnivores and scavengers and fossil bones from their activities could be present in places.

At lower elevations in the landscape, approximately beneath the middles of broad valley trends such as on Plat Vley Farm 1/314 (farm portion comprising the proposed Gromis WEF) and Kap Vley Farm 4/315 (farm portion comprising part of the Komas WEF), there may be buried drainage lines with ephemeral stream deposits interbedded in the Dorbank Fm., and possibly also pan or vlei/seep deposits. Ephemeral stream deposits are poorly fossiliferous, but abraded bone fragments and teeth may occur sparsely in channel lags. As water sources, pan or vlei deposits, and the surrounding surfaces, are associated with a greater prevalence of fossils.

The **palaeontological sensitivity of the Dorbank Formation is considered to be of LOW significance,** but as noted, given the volume of the excavations there is a distinct possibility of fossil bone and teeth finds which could prove to be a scientifically significant addition to the poorly-known mid-Quaternary fossil fauna of Namaqualand.

The calcrete-floored Zonnekwa Valley has very likely hosted pans during wetter climate spells in the past. It is possible that some pan deposits may remain, or fossils that have been eroded from them by wind deflation.

The calcrete is assumed to have formed within the upper part of an older aeolianite formation such as correlates of the Olifantsrivier or Graauw Duinen formations. Fossil bones seem to be more common in these older aeolianites, presumably reflecting more favourable environmental conditions. As the capping calcrete has formed along a persistent palaeosurface, fossil bones are more prevalent within it, but the hard calcrete renders them less easily recoverable in the field as the embedded fossil bone has to be collected using tools to cut out a block of the calcrete.

10 IMPACT ASSESSMENT

10.1 GENERAL IMPACT OF BULK EARTH WORKS ON FOSSILS

Fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be sporadically preserved and have high value with respect to palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

When excavations are made they furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, provided that efforts are made to watch out for and rescue the fossils. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This lost opportunity to recover them and their contexts when exposed at a particular site is irreversible. The scarcity of fossils makes it more important to look out for them.

There remains a moderate to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Machinery involved in excavation may damage or destroy fossils, or they may be hidden in "spoil" of excavated material.

The overall significance of potential impacts to the palaeontological resources on the sites are assessed to be of low negative significance as the fossils are expected to be very sparsely distributed in the ground with a very low probability of impacts actually occurring. If fossil bones are successfully spotted, reported and studied they would make a positive contribution to science. Nevertheless, because of the difficulty of spotting bones, it is still expected that most fossils would not be seen during excavation and with even a few being found the post-mitigation significance is expected to be low positive.

10.2 ASSESSMENT OF CUMULATIVE IMPACTS

Several other WEFs have been proposed in the area. Although this may mean that more impacts to palaeontology are anticipated, there is also the likelihood that there will be a gain in terms of the state of knowledge of these disciplines if mitigation measures are successfully applied. The significance of impacts is expected to be the same as that for the construction phase with **a low negative and low positive** impact to palaeontology.

10.3 ASSESSMENT OF ALTERNATIVES

The No-Go option would entail the site staying as it currently is. This means its continued use for small stock grazing and the continued natural erosion, weathering and trampling by animals. Palaeontological resources would not likely be affected because significant fossils will remain buried. Overall, the significance of impacts related to the no-go option is considered to be **very low negative**.

10.4 COMPARATIVE ASSESSMENT OF ALTERNATIVES

Because of the low palaeontological sensitivity of the sites, there is no material difference between the palaeontological impact of the onsite SS, Eskom Switching SS or the power line routing alternatives (Option 1 or Option 2 alternatives for each proposed WEF) and therefore both these alternatives are considered acceptable for all the alternatives.

10.5 EXTENT

The physical extent of impacts on potential palaeontological resources relates directly to the extent of subsurface disturbance involved in the installation of infrastructure during the Construction Phase of both WEFs.

However, unlike an impact that has a defined spatial extent (*e.g.* loss of a portion of a habitat), the cultural, heritage and palaeontological or scientific impacts are of regional to national extent, as is implicit in the National Heritage Resources, 1999 (Act No. 25 of 1999) and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded palaeontological research that takes place in South Africa by scientists of other nationalities. Lost opportunities that may arise from significant fossil occurrence (tourism, employment) filters down to regional/local levels.

10.6 DURATION

The initial duration of the impact is short to medium term (< 5 years) and occurs with excavations for infrastructure during the Construction Phase. This is the "time window" for mitigation.

The impact of both the finding and the loss of fossils is permanent. The fossils findings must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity. The duration of impact is therefore PERMANENT with or without mitigation.

10.7 INTENSITY

As mentioned above, due to the overall very sparse distribution of fossils in the affected formations **the intensity/palaeontological sensitivity is considered to be of LOW significance**. *Conversely, when fossils are found in such poorly fossiliferous formations, they provide very significant advances in the geological understanding of the stratigraphy of a region (Appendix 3).*

10.8 CONSEQUENCE

The negative impact of the potential loss of irreplaceable fossils is permanent, but the extent is specific to the sites of excavations and the palaeontological sensitivity of the aeolian formations is overall low. **The Consequence is therefore rated as MODERATE**.

10.9 PROBABILITY

In consideration of the scale of subsurface disturbance it is **LIKELY** that fossil bones will be unearthed at some stage during the Construction Phase.

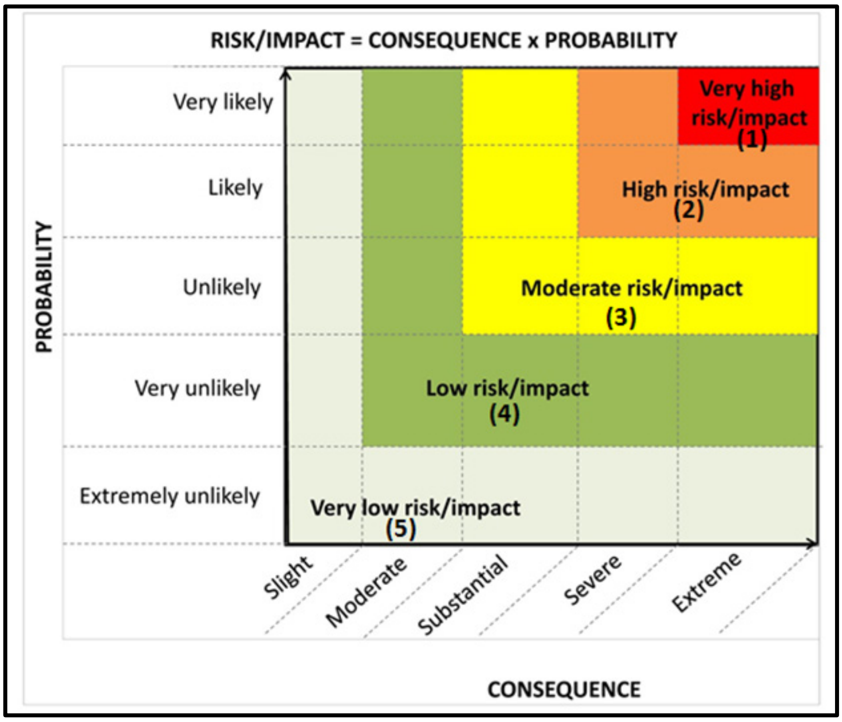


Figure 13. Impact significance as a result of consequence and probability.

10.10 Impact Significance Rating

This assessment of the potential impact of the development on palaeontological resources refers only to the Construction Phase. It does not differentiate between formations as the palaeontological sensitivities of the affected formations with respect to the occurrence of fossil bones are all low. In terms of the rating guide (Figure 13) the **Significance of potential impacts is LOW (4)**.

TABLE 3. IMPACT ASSESSMENT.

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk		Ranking of impact/risk	Confidence level
										Without mitigation	With mitigation (residual risk/impact)		
CONSTRUCTION PHASE													
ALL BULK EARTH WORKS. Foundations and trenches in all aeolian formations	Direct destruction of fossil resources	Negative	Site*	Permanent	Moderate	Likely	Non reversible	High	Monitoring of all construction-phase excavations by project staff and ECO. Reporting of chance finds. Inspection, sampling and recording of selected exposures in the event of fossil finds. Fossil finds and the compiled contextual report deposited in a curatorial scientific institution.	Low negative	Low positive	4	Medium
CUMULATIVE IMPACTS: CONSTRUCTION PHASE													

ALL BULK EARTH WORKS. Foundations and trenches in all aeolian formations	Direct destruction of fossil resources	Negative	Regio-nal*	Permanent	Moderate	Likely	Non reversible	High	Monitoring of all construction-phase excavations by project staff and ECO. Inspection, sampling and recording of selected exposures in the event of fossil finds. Fossil finds and the compiled contextual report deposited in a curatorial scientific institution.	Low negative	Low positive	4	Medium

*If an important fossil find is uncovered the extent of the impact becomes regional-international.

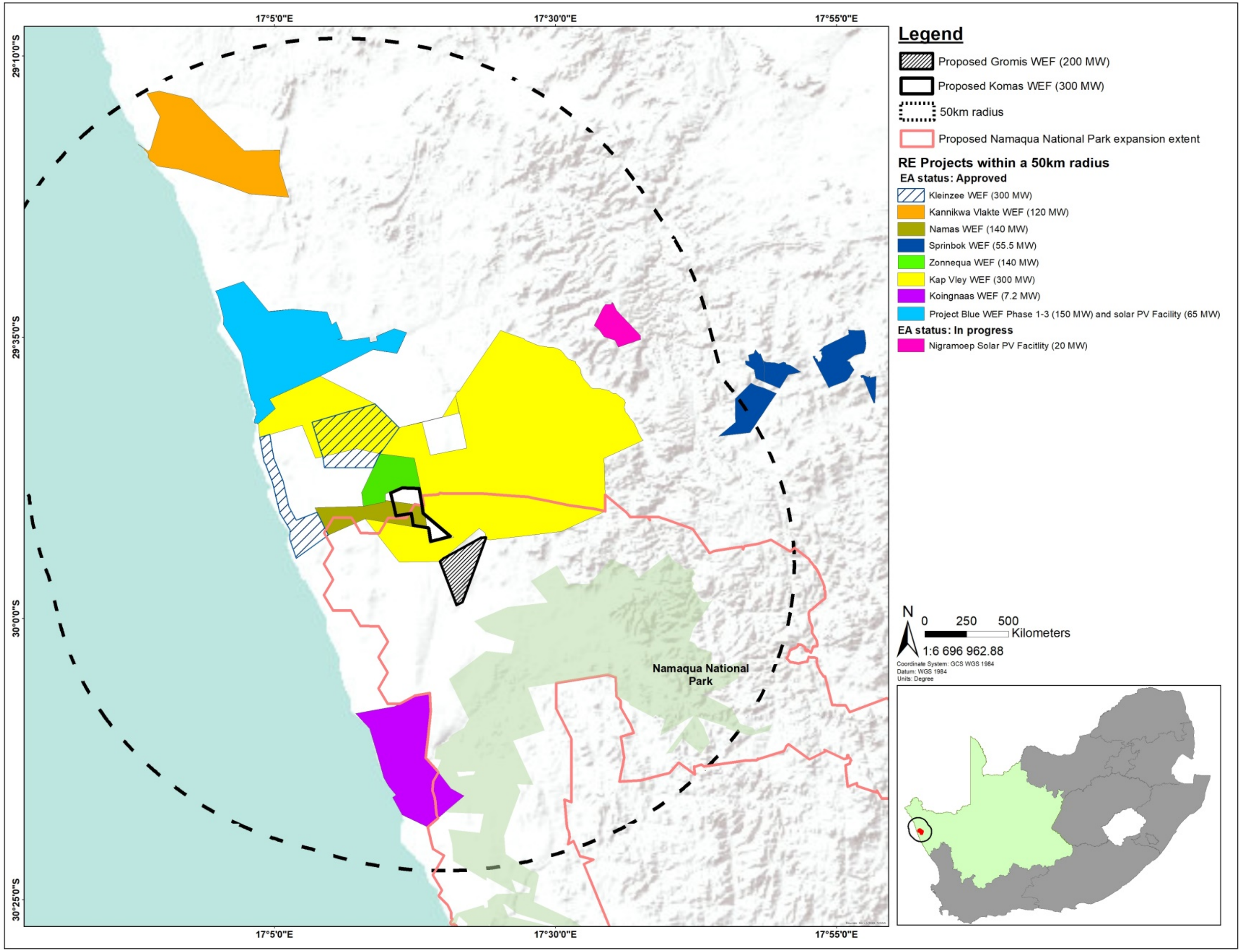


Figure 14. Proposed renewable energy projects within the 50 km radius of the proposed Komas WEF and Gromis WEF sites considered for the Cumulative Impact Assessment

TABLE 4. Proposed renewable energy projects within the 50 km radius of the proposed Komas WEF and Gromis WEF sites considered for the Cumulative Impact Assessment

DEA REFERENCE NUMBER	PROJECT TITLE	APPLICANT	EAP	TECHNOLOGY	MEGAWATT	STATUS
12/12/20/2331/1 12/12/20/2331/1/AM1 12/12/20/2331/2 12/12/20/2331/3	Project Blue Wind Energy Facility Near Kleinsee within the Namakwa Magisterial District, Northern Cape Province. (Phase 1-3)	Diamond Wind (Pty) Ltd	Savannah Environmental Consultants (Pty) Ltd	Wind and Solar PV	150 MW Wind 65 MW Solar PV	Approved
12/12/20/2212	Proposed 300 MW Kleinzee WEF in the Northern Cape Province.	Eskom Holdings SOC Limited	Savannah Environmental Consultants (Pty) Ltd	Wind	300 MW	Approved
14/12/16/3/3/2/1046	The proposed Kap Vley WEF and its associated infrastructure near Kleinzee, Nama Khoi Local Municipality, Northern Cape Province.	Kap Vley Wind Farm (Pty) Ltd	Council for Scientific and Industrial Research	Wind	300 MW	Approved
14/12/16/3/3/1/1971	Proposed Namas Wind Farm near Kleinsee, Namakwaland Magisterial District, Northern Cape.	Genesis Namas Wind (Pty) Ltd	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW	Approved
14/12/16/3/3/1/1970	Proposed Zonnequa Wind Farm near Kleinsee, Namakwaland Magisterial District, Northern Cape.	Genesis Zonnequa Wind (Pty) Ltd	Savannah Environmental Consultants (Pty) Ltd	Wind	140 MW	Approved
12/12/20/2154	Proposed construction of the 7.2 MW Koingnaas Wind Energy Facility Within The De Beers Mining Area on the Farm Koingnaas 745 near Koingnaas, Northern Cape Province.	Just PalmTree Power Pty Ltd	Savannah Environmental Consultants (Pty) Ltd	Wind	7.2 MW	Approved

DEA REFERENCE NUMBER	PROJECT TITLE	APPLICANT	EAP	TECHNOLOGY	MEGAWATT	STATUS
12/12/20/1807	Proposed establishment of the Kannikwa Vlakte wind farm.	Kannikwa Vlakte Wind Development Company Pty Ltd	Galago Environmental cc	Wind	120 MW	Approved
12/12/20/1721 12/12/20/1721/AM1 12/12/20/1721/AM2 12/12/20/1721/AM3 12/12/20/1721/AM4 12/12/20/1721/AM5	The proposed Springbok Wind Energy facility near Springbok, Northern Cape Province.	Mulilo Springbok Wind Power (Pty) Ltd	Holland & Associates Environmental Consultants	Wind	55.5 MW	Approved
TBA	The proposed Gromis WEF and associated infrastructure near Kleinsee in the Northern Cape Province.	Genesis ENERTRAG Gromis Wind (Pty) Ltd	Council for Scientific and Industrial Research	Wind	200 MW	In process
14/12/16/3/3/1/416	Nigramoep Solar PV Solar Energy Facility on a site near Nababeep, Northern Cape.	South African Renewable Green Energy (Pty) Ltd	Savannah Environmental Consultants (Pty) Ltd	Solar PV	20 MW	In process

11 RECOMMENDATIONS

The significance of potential impacts to palaeontological resources was assessed to be LOW NEGATIVE before and LOW POSITIVE after mitigation during the construction phase of the proposed Gromis and Komas WEFs and associated power lines and electrical infrastructure. It is therefore the opinion of the specialist that **development of the proposed Gromis and Komas WEFs and associated power lines and electrical infrastructure is considered acceptable from a palaeontological perspective and can be authorized, subject to the implementation of the recommended mitigation measures.**

Potential adjustments to the layout of the turbines and infrastructure do not affect this assessment.

Both on-site SS alternatives (Option 1 and Option 2) are acceptable from a palaeontological perspective and either alternative may be developed. Similarly, both Eskom Switching Substations and both power line routing alternatives (Option 1 and Option 2 for both) are acceptable from a palaeontological perspective and may be approved.

If the recommended mitigation measures are applied to the proposed Gromis and Komas WEFs, it is possible that these WEF developments will to some extent alleviate the negative cumulative impact on paleontological resources in the region.

The history of these vast tracts of sands, gravels and pedocretes of the Northern Cape Province is very poorly known, with very few fossils to rely on. Therefore, although of low probability; any find will be of considerable importance and could add to the scientific knowledge of the area in a positive manner.

11.1 MONITORING

In view of the low fossil potential, monitoring of bulk earth works by a specialist is not justified. Notwithstanding, the sporadic fossil occurrences are then particularly important and efforts made to spot them are often rewarded. Buried archaeological material may also be encountered.

A recommendation to be included in the EMPr is that the field supervisor/foreman and staff involved in excavations during the construction phase of both WEFs and the associated power lines and electrical infrastructure must be informed to look out for fossils and buried potential archaeological material. Construction staff sighting potential objects of archaeological or palaeontological significance are to cease construction at sighted location and report to the field supervisor who, in turn, must report to the ECO. The ECO must inform the developer and contact the contracted palaeontologist to be on standby in the case of potential fossil finds. The latter will liaise with SAHRA on the nature of the find and consequent actions (permitting and collection of find).

The Fossil Finds Procedure included as Appendix 4 provides guidelines to be followed in the event of fossil finds and should be included in the EMPr. Only a professional palaeontologist may excavate uncovered fossils with a valid mitigation permit from SAHRA.

11.2 Input to the Construction Phase Environmental Management Programme

The following mitigation measures apply to all earthworks affecting all formations discussed above.

<table>
<tr><td colspan="5">TABLE 5. MITIGATION MEASURES.</td></tr>
<tr><td colspan="5">OBJECTIVE: To notice and rescue fossil material that may be exposed in the excavations during the construction of the WEF.</td></tr>
<tr><th>ACTIVITY</th><th>POTENTIAL IMPACT</th><th>MITIGATION</th><th>RESPONSIBLE PARTY</th><th>TIME FRAME</th></tr>
<tr><td rowspan="7">All bulk earthworks, viz. turbine foundation excavations, trenches for cabling & infrastructure, power line and substation foundations, spoil from excavations.</td><td rowspan="7">Loss of fossils by their being unnoticed and/ or destroyed.</td><td>Inform staff of the need to watch for potential fossil occurrences.</td><td>The Developer, the ECO and contractors</td><td>Pre-construction</td></tr>
<tr><td>Inform staff of the Fossil Finds Procedures to be followed in the event of fossil occurrences.</td><td>ECO/Specialist</td><td>Pre-construction</td></tr>
<tr><td>Monitor for the presence of fossils.</td><td>Contracted personnel and ECO</td><td>Construction</td></tr>
<tr><td>Liaise with palaeontologist on the nature of potential finds and appropriate actions.</td><td>ECO and Specialist, SAHRA</td><td>Construction</td></tr>
<tr><td>ECO to conduct inspections of open excavations whenever on site.</td><td>ECO</td><td>Construction</td></tr>
<tr><td>Obtain a permit from SAHRA for the fossil finds collection should resources be discovered.</td><td>Developer and Specialist</td><td>Construction</td></tr>
<tr><td>Excavate main finds, inspect pits and record and sample excavations.</td><td>Specialist</td><td>Construction</td></tr>
<tr><td colspan="2">PERFORMANCE INDICATORS</td><td colspan="3">Reporting of and liaison about possible fossil finds.
Fossils noticed and rescued.
Scientific record of fossil contexts and temporary exposures in earthworks.</td></tr>
</table>

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13 APPENDIX 1 – CURRICULUM VITAE

John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)

Independent Consultant/Researcher recognized as an authority with 37 years' experience in the field of coastal-plain and continental-shelf palaeoenvironments, fossils and stratigraphy, mainly involving the West Coast/Shelf of southern Africa. Has been previously employed in academia (South African Museum) and industry (Trans Hex, De Beers Marine). At present an important involvement is in Palaeontological Impact Assessments (PIAs) and mitigation projects in terms of the National Heritage Resources Act 25 (1999) (~300 PIA reports to date) and is an accredited member of the Association of Professional Heritage Practitioners (APHP). Continues to be involved as consultant to offshore and onshore marine diamond exploration ventures. Expertise includes:

- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures, on/offshore cores and exploration drilling).
- Sedimentology and palaeoenvironmental interpretation of shallow marine, aeolian and other terrestrial surficial deposits.
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods) and biostratigraphy.
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).

Membership of Professional Bodies

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Association of Professional Heritage Practitioners (APHP), Western Cape. Accredited Member No. 48.

Past Clients Palaeontological Assessments

AECOM SA (Pty) Ltd.	Guillaume Nel Environmental Management Consultants.
Agency for Cultural Resource Management (ACRM).	Klomp Group.
AMATHEMBA Environmental.	Megan Anderson, Landscape Architect.
Anél Blignaut Environmental Consultants.	Ninham Shand (Pty) Ltd.
Arcus Gibb (Pty) Ltd.	PD Naidoo & Associates (Pty) Ltd.
ASHA Consulting (Pty) Ltd.	Perception Environmental Planning.
Aurecon SA (Pty) Ltd.	PHS Consulting.
BKS (Pty) Ltd. Engineering and Management.	Resource Management Services.
Bridgette O'Donoghue Heritage Consultant.	Robin Ellis, Heritage Impact Assessor.
Cape Archaeology, Dr Mary Patrick.	Savannah Environmental (Pty) Ltd.
Cape EAPrac (Cape Environmental Assessment Practitioners).	Sharples Environmental Services cc
CCA Environmental (Pty) Ltd.	Site Plan Consulting (Pty) Ltd.
Centre for Heritage & Archaeological Resource Management (CHARM).	SRK Consulting (South Africa) (Pty) Ltd.
Chand Environmental Consultants.	Strategic Environmental Focus (Pty) Ltd.
CK Rumboll & Partners.	UCT Archaeology Contracts Office (ACO).
CNdV Africa	UCT Environmental Evaluation Unit
CSIR - Environmental Management Services.	Urban Dynamics.
Digby Wells & Associates (Pty) Ltd.	Van Zyl Environmental Consultants
Enviro Logic	Western Cape Environmental Consultants (Pty) Ltd, t/a ENVIRO DINAMIK.
Environmental Resources Management SA (ERM).	Wethu Investment Group Ltd.
Greenmined Environmental	Withers Environmental Consultants.

Stratigraphic consulting including palaeontology

Afri-Can Marine Minerals Corp	Council for Geoscience
De Beers Marine (SA) Pty Ltd.	De Beers Namaqualand Mines.
Geological Survey Namibia	IZIKO South African Museum.
Namakwa Sands (Pty) Ltd	NAMDEB

14 APPENDIX 2- SPECIALIST DECLARATION

15 APPENDIX 3- PALAEONTOLOGICAL SENSITIVITY RATING

Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit.

VERY HIGH: Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.

HIGH: Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

MODERATE: Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

LOW: Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

MARGINAL: Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the meta sedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

NO POTENTIAL: Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

Adapted from Society of Vertebrate Paleontology. 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin, Vol. 163, p. 22-27.

16 APPENDIX 4 - FOSSIL FIND PROCEDURES

16.1 MONITORING

A constant monitoring presence over the period during which excavations for developments are made, by either an archaeologist or palaeontologist, is generally not practical.

The field supervisor/foreman and workers involved in digging excavations must be encouraged and informed of the need to watch for potential fossil and buried archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the ECO.

The ECO will inform the archaeologist and/or palaeontologist contracted to be on standby in the case of fossil finds.

To this end, responsible persons must be designated. This will include hierarchically:

- The field supervisor/foreman, who is going to be most often in the field.
- The Environmental Control Officer (ECO) for the project.
- The Project Manager/Site Agent.

16.2 RESPONSE BY PERSONNEL IN THE EVENT OF FOSSIL FINDS

In the process of excavation fossils may be spotted in the hole sides or bottom, or as they appear in excavated material on the spoil heap.

- Stop work at fossil find. The site foreman and ECO must be informed.
- Protect the find site from further disturbance and safeguard all fossil material in danger of being lost such as in the excavator bucket and scattered in the spoil heap.
- The ECO or site agent must immediately inform the SAHRA and/or the contracted standby palaeontologist of the find and provide via email the information about the find, as detailed below.
    - Date
    - Position of the excavation (GPS) and depth.
    - A description of the nature of the find.
    - Digital images of the excavation showing vertical sections (sides) and the position of the find showing its depth/location in the excavation.
    - A reference scale must be included in the images (tape measure, ranging rod, or object of recorded dimensions).
    - Close-up, detailed images of the find (with scale included).

The SAHRA and/or the contracted standby palaeontologist will assess the information and a suitable response will be established which will be reported to the developer and the ECO, such as whether rescue excavation or rescue collection by a palaeontologist is necessary or not. The response time/scheduling of the rescue fieldwork is to be decided in consultation with developer/owner and the ECO. It will probably be feasible to "leapfrog" the find and proceed to the next excavation, or continue a trench excavation farther along, so that the work schedule and machine time is minimally disrupted. The strategy is to rescue the material as quickly as possible.

16.3 APPLICATION FOR A PERMIT TO COLLECT FOSSILS

A permit from SAHRA is required to excavate fossils. The applicant should be the qualified specialist responsible for assessment, collection and reporting (palaeontologist). Should fossils be found that require rapid collecting, application for a palaeontological permit must immediately be made to SAHRA. All fossils must be deposited at a SAHRA-approved institution. In addition to the information and images of the find, the application requires details of the registered owners of the sites, their permission and a site-plan map.