SOUTH AFRICA MAINSTREAM RENEWABLE POWER DEVELOPMENTS (PTY) LTD

Xha! Wind Energy Facility (WEF) – 132kV Grid connection and substation

Heritage Impact Report

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Executive Summary

PGS was appointed by SiVEST Environmental Division (SiVEST) to undertake a Heritage Impact Assessment that forms part of the Basic Environmental Assessment Report and Environmental Management Plan for the Xha! Boom WEF 132kV grid connection and substation for South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream), near Loeriesfontein in the Northern Cape Province.

Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The background research completed in October 2016 has shown that the proposed Hartebeest Leegte WEF grid connection and substation to be developed as a WEF may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

The subsequent field work completed for the October 2016 and June 2017, has confirmed the presence of 1 heritage resource (XHA003) as well as several areas with existing infrastructure such as fenced off camps, windmills and reservoirs.

1.1 Impact and Cumulative Impact

Only one low significance identified heritage resources is affected by the proposed grid connection and substation layout. The impact by the proposed development on heritage resources will be low to negligible.

It is my considered opinion that this additional load on the overall impact on heritage resources will have a low to negligible cumulative impact.

None of the alternatives are deemed to be unfavourable and all can be utilised from a heritage point of view.

1.2 Mitigation

The design process and methodology followed by the developer for this project will enabled the heritage assessment to provide input into the proposed layouts. This resulted in cognisance being taken of the positions of the heritage resources and thus the reduction of impacts at an early design phase

The mitigation measures proposed is a follows:

1.3 Pre-Construction

1. A walk down of the final layout to determine if any significant sites will be affected.
2. Monitor find spot areas if construction is going to take place through them.
3. A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations. Possible surface collections for sites with a medium to high significance as well as conducting a watching brief by heritage practitioner during the construction phase.

1.4 Palaeontology

The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian rocks of the lower part of the Ecca Group (Karoo Supergroup). This include the Prince Albert, Whitehill and Tierberg Formations. Permian. The Jurassic bedrocks are covered with a range of superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age.

According to the SAHRIS PlaeoMap the Dwyka Group has a low Palaeontological Sensitivity while the Ecca Group (Tierberg and Whitehill Fromations) has a moderate palaeontological Sensitivity. But, the Palaeontological Sensitivity of the Prince Albert Formation is High. The Karoo Dolerite Suite consists of igneous rocks and are unfossiliferous. Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. Due to the High Palaeontological sensitivity of the Prince Albert Formation (Ecca Group) a site visit is thus recommended.

Prior to construction a detailed palaeontology study will thus be conducted to assess the value and importance of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the detailed Report is to elaborate on the issues and potential impacts identified during the initial study undertaken for the Basic Assessment (BA). This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the BA. The report will be submitted to SAHRA before the commencement of any development-related activities

MAINSTREAM RENEWABLE POWER DEVELOPMENTS (PTY) LTD

HERITAGE IMPACT REPORT

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1 INTRODUCTION

PGS Heritage (Pty) Ltd was appointed by SiVEST Environmental Division to undertake a Heritage Impact that forms part of the basic Environmental Assessment Report (BAR) and Environmental Management Plan (EMP) for the Xha! Boom Wind Energy 132kV grid connection and substation for South Africa Mainstream Renewable Power Developments (Pty) Ltd, near Loeriesfontein in the Northern Cape Province.

1.1 Scope of the Study

The aim of the study is to identify possible heritage resources, finds and sensitive areas that may occur in the study area to inform the BAR in the development of a comprehensive EMP to assist the developer in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999) (NHRA).

1.2 Assumptions and Limitations

Not detracting in any way from the comprehensiveness of the fieldwork undertaken, it is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the development area. Various factors account for this, including the subterranean nature of some archaeological sites. As such, should any heritage features and/or objects not included in the present inventory be located or observed, a heritage specialist must immediately be contacted.

1.3 Specialist Qualifications

PGS Heritage (PGS) compiled this HIA.

The staff at PGS has a combined experience of nearly 80 years in the heritage consulting industry. PGS and its staff have extensive experience in managing the HIA processes. PGS will only undertake heritage assessment work where they have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, author and project manager for this project, is registered as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA) and has CRM accreditation within the said organisation, as well as being accredited as a Professional Heritage Practitioner with the Association of Professional Heritage Practitioners – Western Cape (APHP)

Jessica Angel holds a Masters degree in Archaeology and is registered as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA).

Marko Hutten, heritage specialist and project archaeologist, has 18 years of experience in the industry and is registered with the Association of Southern African Professional Archaeologists (ASAPA) as a Professional Archaeologist and is accredited as a Field Director.

1.4 Legislative Context

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

- National Environmental Management Act (NEMA), Act 107 of 1998
- National Heritage Resources Act (NHRA), Act 25 of 1999
- Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002

The following sections in each Act refer directly to the identification, evaluation and assessment of cultural heritage resources.

- National Environmental Management Act (NEMA) Act 107 of 1998
    a. Basic Environmental Assessment (BEA) – Section (23)(2)(d)
    b. Environmental Scoping Report (ESR) – Section (29)(1)(d)
    c. Environmental Impact Assessment (EIA) – Section (32)(2)(d)
    d. Environmental Management Plan (EMP) – Section (34)(b)
- National Heritage Resources Act (NHRA) Act 25 of 1999
    a. Protection of Heritage Resources – Sections 34 to 36; and
    b. Heritage Resources Management – Section 38
- Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Section 39(3)

The NHRA stipulates that cultural heritage resources may not be disturbed without authorization from the relevant heritage authority. Section 34(1) of the NHRA states that, “no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…”

The NHRA is utilised as the basis for the identification, evaluation and management of heritage resources and in the case of CRM those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through NEMA and MPRDA legislation. In the latter cases, the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorizations are granted for development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impacts Processes required by NEMA and MPRDA. This change requires us to evaluate the Sections of these Acts relevant to heritage.

The NEMA 23(2)(b) states that an integrated environmental management plan should, “…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage”.

A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be taken account of in the Regulations under NEMA is the Specialist Report requirements laid down in Section 33 of the regulations (Fourie, 2008).

Refer to **Appendix A** for further discussions on heritage management and legislative frameworks

Table 1: Terminology

Acronyms	**Description**
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
BAR	Basic Environmental Impact Assessment Report
CI	Cumulative Impacts
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Earlier Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LSA	Later Stone Age
LIA	Late Iron Age
MSA	Middle Stone Age
MIA	Middle Iron Age
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Agency
PSSA	Palaeontological Society of South Africa
ROD	Record of Decision
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency
WEF	Wind Energy Facility

Archaeological resources

This includes:

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

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

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

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

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

Earlier Stone Age
The archaeology of the Stone Age, between 700 000 and 2 500 000 years ago.

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

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

Heritage resources
This means any place or object of cultural significance, such as the caves with archaeological deposits identified close to both development sites for this study.

Holocene

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

Later Stone Age

The archaeology of the last 30 000 years associated with fully modern people.

Late Iron Age (Early Farming Communities)

The archaeology of the last 1000 years up to the 1800's, associated with iron-working and farming activities such as herding and agriculture.

Middle Stone Age

The archaeology of the Stone Age between 30 000-300 000 years ago, associated with early modern humans.

Palaeontology

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

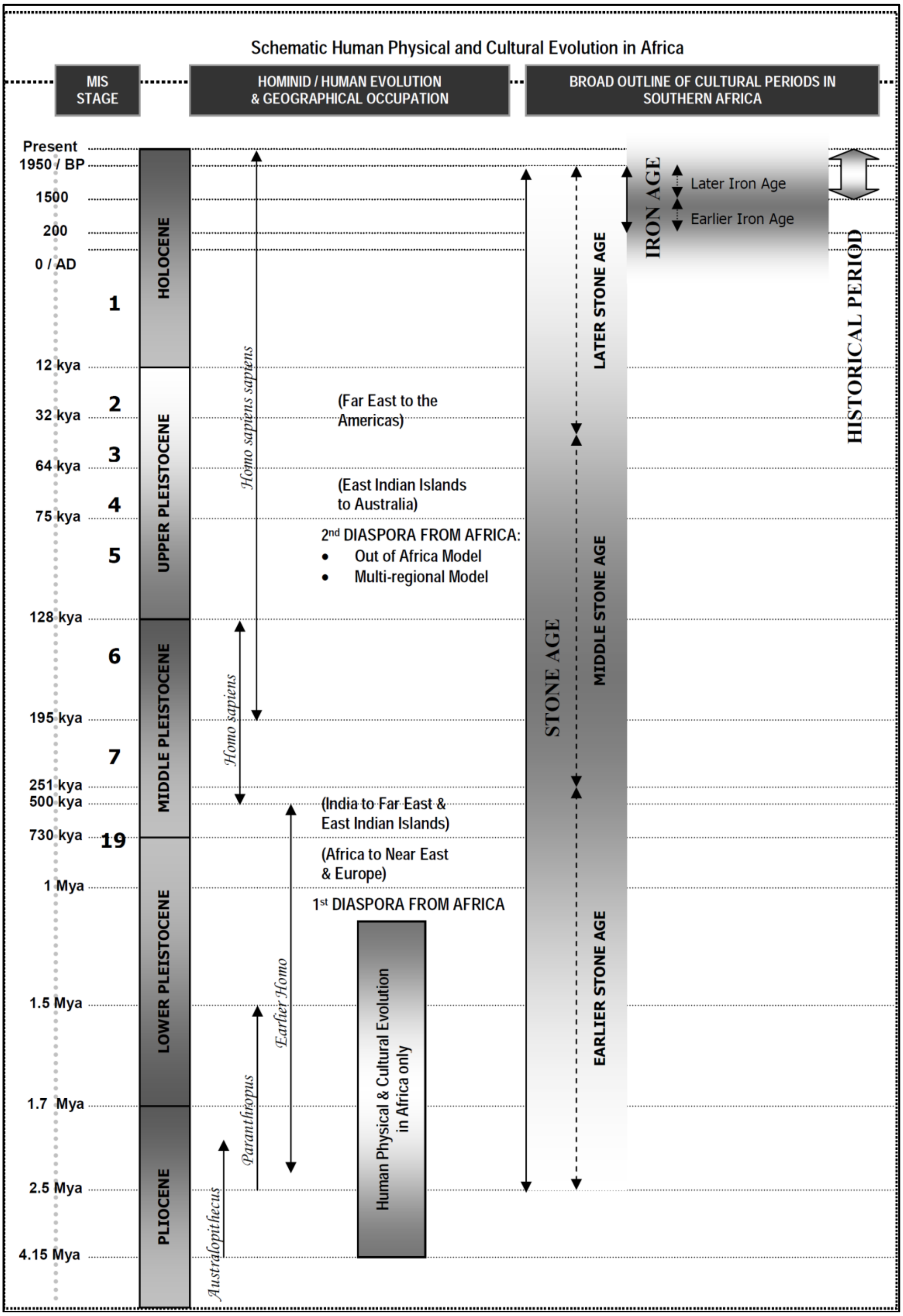

Figure 1: Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Project Location

South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as Mainstream) are proposing to construct a 33kV/132kV on-site substation, namely the Xha! Boom Substation, a 132kV Linking Substation and an associated 132kV power line near Loeriesfontein in the Northern Cape Province (hereafter referred to as the 'proposed development'). The proposed development is aimed at feeding electricity generated by Mainstream's proposed Xha! Boom Wind Farm (part of separate on-going EIA process) into the national grid.

2.2 Project Description

At this stage, it is understood that the proposed development will include a 33kV/132kV on-site IPP substation (namely Xha! Boom Substation), as well as a 132kV Linking Substation and a 132kV power line. The aim of this development is to feed electricity generated by the proposed Xha! Boom Wind Farm (part of separate on-going EIA process) into the national grid.

The proposed development will include the following main activities:

- Construction of 1 x 33kV/132kV substation (referred to as the "proposed Xha! Boom Substation")
- Construction of 1 x 132kV linking substation
- Construction of 1 x 132kV power line from the proposed Xha! Boom Substation, via the proposed Linking Substation to Helios substation, approximately 35km south-east of the proposed Xha! Boom Wind Farm.

The size of the proposed on-site substation site will be approximately 500m x 300m, while the Linking Substation site will be approximately 600m x 600m. A power line corridor of between 100m and 500m wide is being proposed to allow flexibility when determining the final route alignment. The proposed power line however only requires a 31m wide servitude and as such, this servitude would be positioned within the corridor.

It should be noted that two (2) alternative sites for the proposed on-site Xha! Boom Substation and the proposed Linking Substation have been assessed during the Basic Assessment (BA), in conjunction with four (4) power line corridor alternatives.

The proposed power line will include a series of towers located approximately 170m to 250m apart. The type of towers being considered at this stage include self-supporting suspension monopole structures (**Figure 2**) for relatively straight sections of the line and angle strain towers where the line bends to a significant degree. The steel monopole tower type is between 18 and 25m in height, depending on the terrain, but will ensure minimum overhead line clearances from buildings and surrounding infrastructure. The exact location of the towers will be determined during the final design stages of the power line.

Figure 2: Tower Type

The proposed Xha! Boom Wind Farm (part of a separate on-going EIA process) application site, proposed Xha! Boom Substation site and associated 132kV power line corridor route alternatives are shown in the locality map below (**Figure 3).**

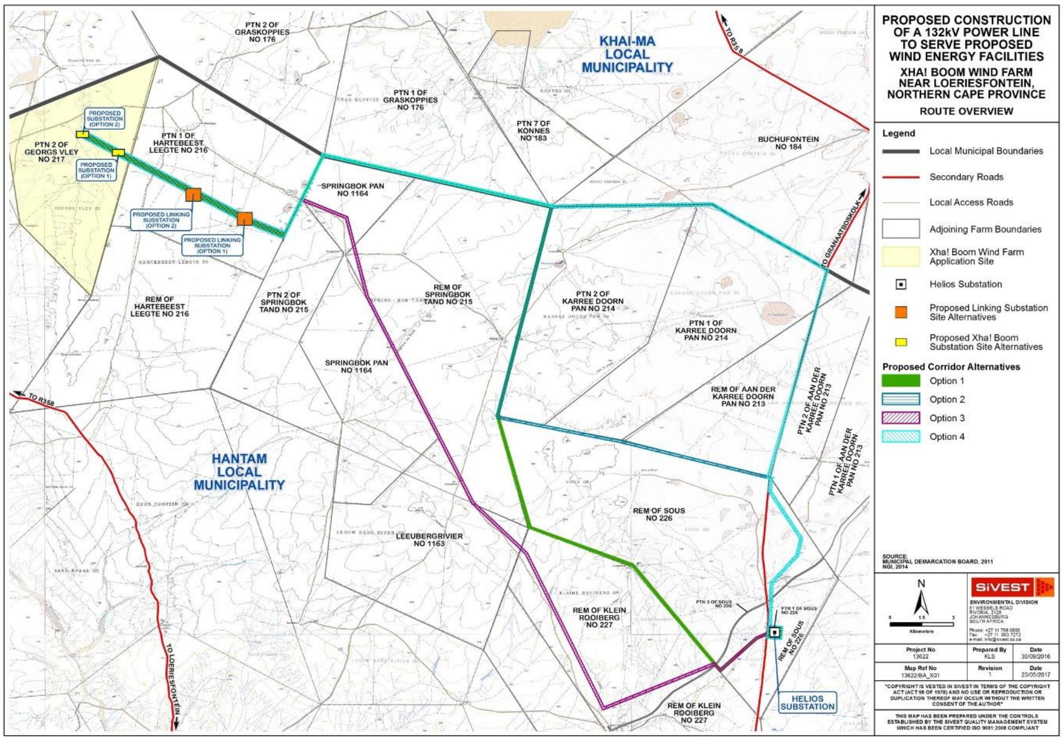

Figure 3: Site Locality Map

3 ASSESSMENT METHODOLOGY

The section below outlines the assessment methodologies utilised in the study.

3.1 Methodology for Assessing Heritage Site significance

This HIA report was compiled by PGS for the proposed Xha! Boom WEF 132kV grid connection and substation. The applicable maps, tables and figures, are included as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998). The HIA process consisted of three steps:

Step I – Literature Review: The background information to the field survey relies greatly on the Heritage Background Research.

Step II – Physical Survey: A physical survey was conducted on foot and by vehicle through the proposed project area by two qualified archaeologists and two field assistants, which aimed at locating and documenting sites falling within and adjacent to the proposed development footprint. *Completed end of October 2016 and June 2017*.

Step III – The final step involved the recording and documentation of relevant archaeological resources, the assessment of resources in terms of the HIA criteria and report writing, as well as mapping and constructive recommendations.

Appendix B, outlines the HIA methodology, while **Appendix C** provides the guidelines for the impact assessment evaluation that was used in this EIA evaluation.

4 BACKGROUND RESEARCH

The examination of heritage databases, historical data and cartographic resources represents a critical additional tool for locating and identifying heritage resources and in determining the historical and cultural context of the study area. Therefore, an Internet literature search was conducted and relevant archaeological and historical texts were also consulted. Relevant topographic maps and satellite imagery were studied.

4.1 Previous Studies

Researching the SAHRA APM Report Mapping Project records and the SAHRIS online database (http://www.sahra.org.za/sahris), it was determined that a number of other archaeological or historical studies have been performed within the wider vicinity of the study area. Previous studies listed for the area in the APM Report Mapping Project included a number of surveys within the area listed in chronological order below:

- MORRIS, DAVID. 2007. Archaeological Specialist input with respect to the upgrading railway infrastructure on the Sishen-Saldanha ore line in the vicinity of Loop 7a near Loeriesfontein. McGregor Museum.
- FOURIE, WOUTER. 2011. Heritage Impact Assessment for the proposed Solar Project on the farm Kaalspruit, Loeriesfontein. PGS Heritage and Grave Relocation Consultants.
- ALMOND, J.E. 2011. Palaeontological Desktop Study for the Proposed Mainstream Wind Farm Near Loeriesfontein, Namaqua District Municipality, Northern Cape Province.
- VAN SCHALKWYK, J. 2011. Heritage Impact Assessment for the proposed establishment of a wind farm and PV facility by Mainstream Renewable Power in the Loeriesfontein Region, Northern Cape Province.
- VAN DER WALT, JACO. 2012. Archaeological Impact Assessment for the proposed Hantam PV Solar Energy Facility on the farm Narosies 228, Loeriesfontein, Northern Cape Province.
- WEBLEY, L & HALKETT, D. 2012. Heritage Impact Assessment: Proposed Loeriesfontein Photo-Voltaic Solar Power Plant On Portion 5 of the Farm Klein Rooiberg 227, Northern Cape Province.
- MORRIS, DAVID. 2013. Specialist Input for the Environmental Basic Assessment and Environmental Management Program for the Khobab Wind Energy Facility: Power Line Route Options, Access Road And Substation Positions.
- ORTON, JAYSON. 2014. Heritage Impact Assessment for the proposed re-alignment of the authorized 132kV Power Line for the Loeriesfontein 2 WEF, Calvinia Magisterial District, Northern Cape.

4.1.1 Findings from the studies

Palaeontology

The following section has been compiled by Elize Butler for PGS Heritage. The full report can be viewed in **Appendix D** of this report.

The development footprint (**Figure 4**) is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian basinal rocks of the lower part of the Ecca Group (Karoo Supergroup). They are assigned to the Prince Albert Formation, Whitehill Formation and Tierberg Formation in order of decreasing age. The Ecca Group were laid down surrounded by the marine to freshwater Ecca Sea.

These mudrocks are generally weathered, and forms landscapes of low relief. The Ecca Group sediments, and in particular the Whitehil Formation, are intruded by Early Jurassic (183 ± 2 Million years old) igneous intrusions of the Karoo Dolerite Suite (Duncan & Marsh 2006). These basic sills thermally metamorphosed or baked the neighbouring Ecca country rocks. The Permian and Jurassic bedrocks are in many areas mantled with a variety of superficial deposits, most of which is probably of Late Caenozoic (Quaternary to Recent) age. This include doleritic superficial rubble, gravelly to silty river alluvium and pan sediments and small patches of aeolian sands. The intrusive Karoo dolerites has no palaeontological significance and the Late Caenozoic superficial deposits are generally of low palaeontological sensitivity.

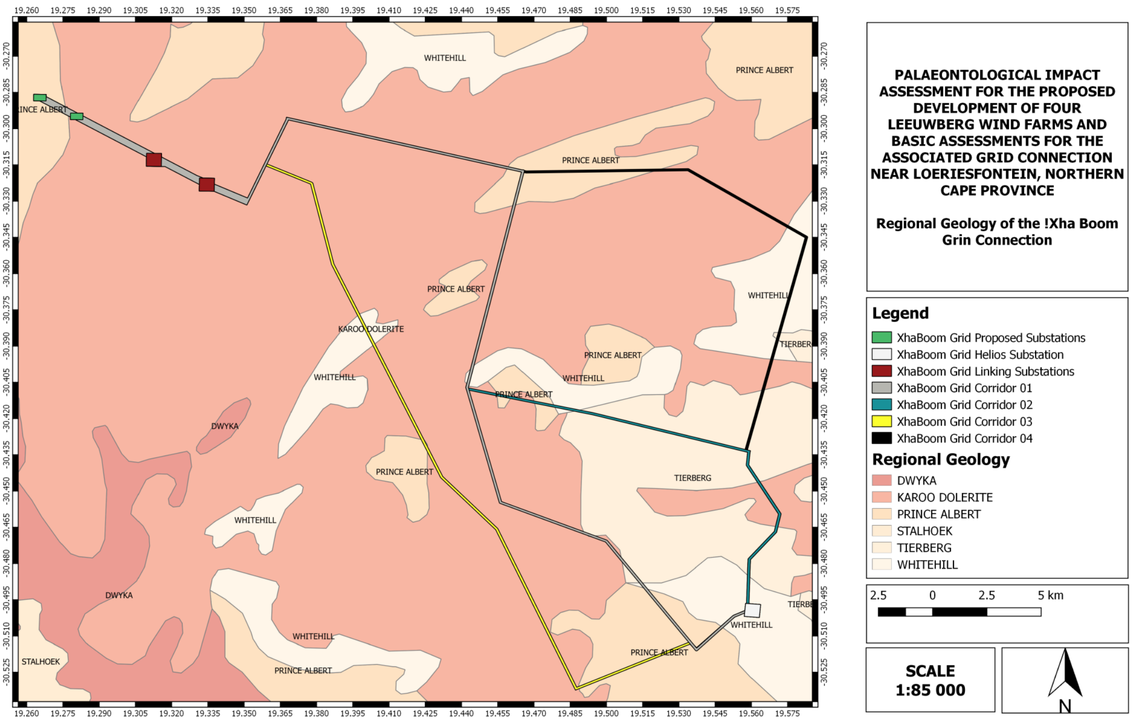

Figure 4: The surface geology of the proposed grid connection for the Xha! Boom Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert Formation of the Ecca Group.

Archaeology

Although a study conducted by Morris (2007) have indicated minimal finds of archaeological sites in the vicinity of the upgrade of Loop 7A of the Sishen-Saldanha ore line to the north of the study area, discussions with local framers have indicated the occurrence of some archaeological sites.

Morris (2010) notes that previous studies have indicated that substantial MSA scatters is fairly uncommon in the Bushmanland/Namaqualand areas. While herder sites where more limited to sheltered and dune areas close to water sources such as pans and rivers.

The HIA's (Fourie, 2011; Van Schalkwyk, 2011; Webley & Halkett, 2012 and Orton, 2014) and the AIA's (Morris, 2007; Van der Walt, 2012 and Morris, 2013), have added to the body of work conducted in the area since the observations of Beaumont et al. (1995), that "thousands of square kilometres of Bushmanland area covered by a low density lithic scatter".

Orton (2014) notes that previous studies in the vicinity of the current study area, have found and assessed archaeological material dating to the early (ESA), Middel (MSA) and Later (LSA) Stone Ages.

4.1.2 Heritage sensitivities

The evaluation of the possible heritage resource finds and their heritage significance linked to mitigation requirements was linked to types of landscape. The heritage sensitivity rating does not indicate no-go areas but the possibility of finding heritage significant site that could require mitigation work.

4.1.3 Possible finds

Evaluation of aerial photography has indicated that certain areas may be sensitive from an archaeological perspective. The analysis of the studies conducted in the area assisted in the development of the following landform type to heritage find matrix in **Table 2.**

Table 2: Landform to heritage matrix

LAND FROM TYPE	**HERITAGE TYPE**
Crest and foot hill	LSA and MSA scatters
Crest of small hills	Small LSA sites – scatters of stone artefacts, ostrich eggshell, pottery and beads
Pans	Dense LSA sites
Outcrops	Occupation sites dating to LSA
Farmsteads	Historical archaeological material

5 FIELD WORK FINDINGS

5.1 Methodology

A survey of the study area was conducted from 24-30 October 2016 and June 2017. Due to the nature of cultural remains, with the majority of artefacts occurring below surface, two archaeologists of PGS conducted a vehicle and foot-survey that covered the study area. The fieldwork was logged with a GPS to provide a background of the areas covered (**Figure 7**).

The proposed study area is situated approximately 75 kilometres north of Loeriesfontein off the R355 in the Northern Cape.

The proposed site is characterised by a flat arid landscape. The vegetation is typical Karoo. The area is being utilized for game (mostly springbok) and sheep.

Figure 5: View of the western side of the study area.

Figure 6: View of the southern side of the study area from the ridge

5.2 Findings

The fieldwork identified 1 heritage resource (**GK004**) as well as several areas with existing infrastructure such as fenced off camps, windmills and reservoirs.

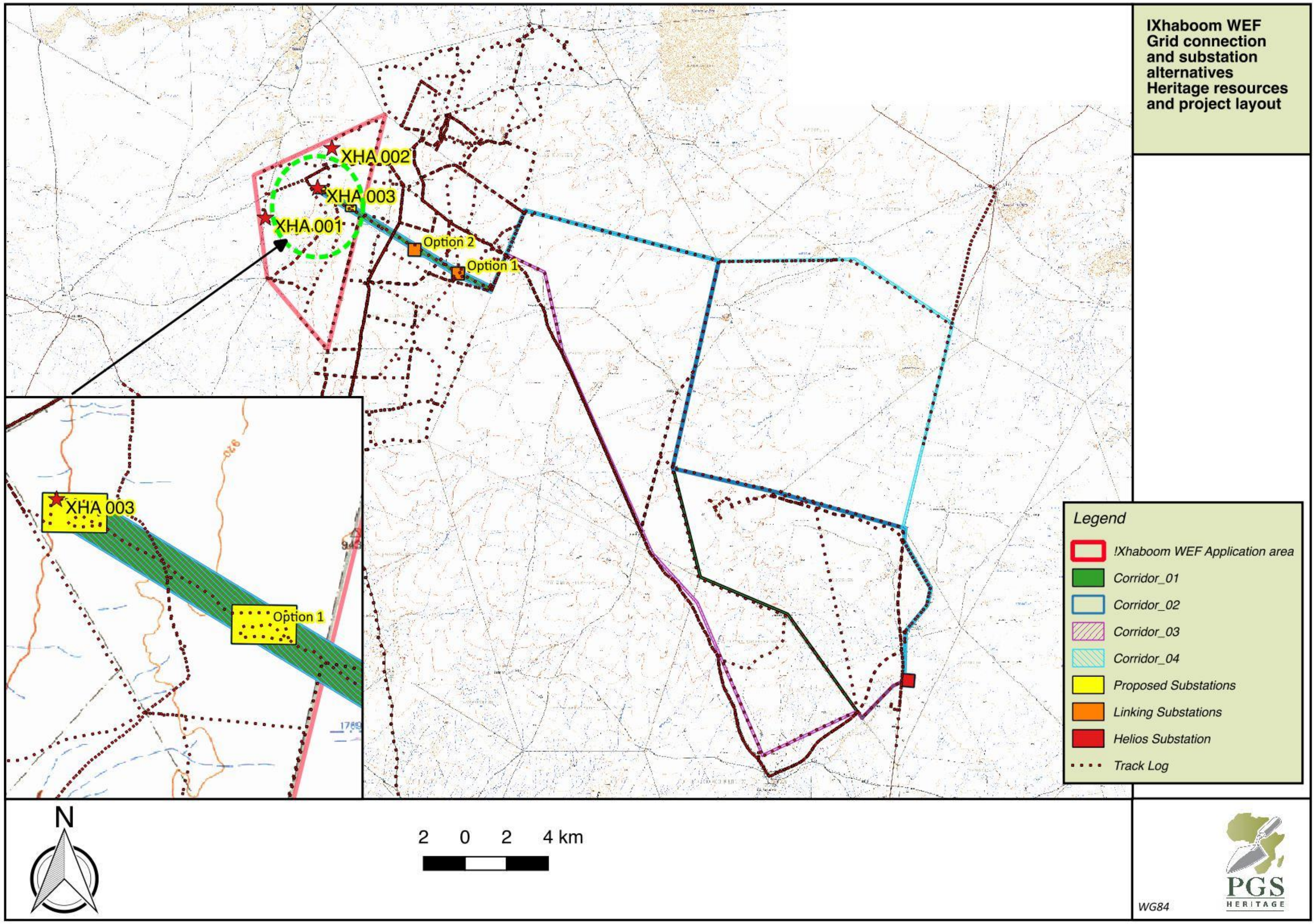

Figure 7: Heritage resources with tracklog

Table 3: Heritage resources found

Site Number	Lat	Lon	Type Find	Description	Significance	Heritage Rating
XHA 003	S30.286190°	E19.263994°	Find spot	A low density scatter of lithic tools was identified at this location (± 2-5 artefacts in 10m x10m). The site is situated within a pan amongst the grassy plains of the study area. The artefacts were exposed in some deflated areas due to some measure of sheet erosion. The lithic tools are mainly from the Late Stone Age (LSA) and consist mostly of utilised and re-touched flakes, scrapers, blades and cores. The artefacts are mainly made of weathered quartzite, hornfels and CCS and they were found scattered over an area which measured approximately 60m in diameter. The site is of low significance and no further mitigation is necessary.	Low	GP.C

Figure 8: General view of XHA 003

Figure 9: View of landscape showing lithic distribution

Figure 10: Artefacts identified at XHA 003

6 IMPACT ASSESSMENT

The proposed WEF layout in relation to the identified heritage resources is shown in **Figure 11**.

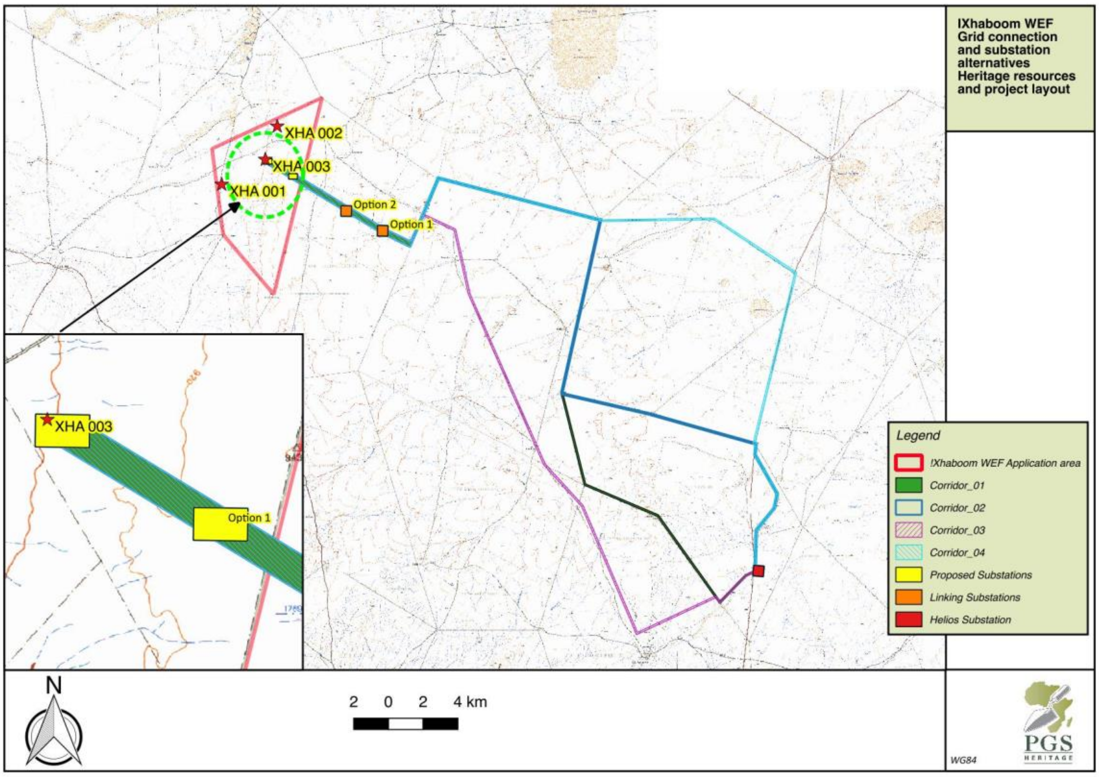

Figure 11: Propose Xha! Boom WEF grid connection and substation alternatives in relation to the identified heritage resources

The impact rating and analysis was done based on the methodology as explained and summarised in **Appendix C** of this report. The design process and methodology followed by the developer for this project has enabled the heritage assessment to provide input into the proposed layouts. This resulted in cognisance being taken of the positions of the heritage resources and thus the reduction of impacts at an early design phase. Analysis of the impact matrix tables reflect this fact.

Only one low significance heritage resources are affected by the proposed grid connection or substation alternatives and the following impact assessment tables are based on this fact.

6.1 Impact matrix

Table 4: Impact rating - Palaeontology

IMPACT TABLE	
Environmental Parameter	*Impact on the Palaeontology Heritage (fossils) of the development footprint*
Issue/Impact/Environmental Effect/Nature (E)	The excavations and vegetation clearance during the construction phase will involve extensive excavations into the superficial deposits as well as locally into the underlying bedrock. These excavations will transform the present topography and may disrupt and destroy or permanently lock-in fossils at or beneath the ground surface that are no longer accessible for research. This impact will usually only occur during the construction phase. No impacts are expected to occur during the operation phase.
Extent	The Leeuwberg Wind Farm project area will be located approximately 62km north of Loeriesfontein, in the Khai-ma and Hantam Local Municipalities within the Northern Cape Province. *A brief description of the area over which the impact will be expressed*
Probability	The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian basinal mudrocks of the lower part of the Ecca Group (Karoo Supergroup). Permian and Jurassic bedrocks are covered with various superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age. The intrusive Karoo dolerites are of no palaeontological significance and the Late Caenozoic superficial deposits are generally of very low palaeontological sensitivity. The Dwyka Group is known for fish, microfossils, marine invertebrates, trace fossils and vascular plants. Aquatic vertebrate fossils (fish and mesosaurid reptiles), invertebrates and petrified wood has been identified from the Whitehill Formation. These fossils are infrequent in the Prince Albert and Tierberg Formations. According to the SAHRIS PlaeoMap the Dwyka Group has a low Palaeontological Sensitivity while the Ecca Group (Tierberg and Whitehill Fromations) has a moderate palaeontological Sensitivity. But, the Palaeontological Sensitivity of the Prins Albert Formation is High. The probability of significant impacts on palaeontological heritage during the construction phase is low.
Reversibility	Impacts on fossil heritage are commonly irreversible. And thus well-documented records and additional palaeontological studies of fossils exposed through construction would characterise a positive impact scientifically. The probability of a negative impact on the palaeontological heritage of the area can be reduced by the execution of suitable damage mitigation procedures. If damage mitigation is correctly undertaken the benefit scale for the project will lie within the beneficial category. *Fossil Heritage is expected in the Prins Albert Formation while the Ecca group has a moderate probability and the Dwyka Group a low probability of finding fossils*
Irreplaceable loss of resources	The development footprint is underlain by the Dwyka Group (low Palaeontological Sensitivity) and Ecca Group of the Karoo Supergroup. This include the Prince Albert (high Palaeontological Sensitivity), Whitehill and Tierberg with a moderate Palaeontological Sensitivity. Permian and Jurassic bedrocks are covered with a range of superficial deposits generally of low palaeontological sensitivity. The intrusive Karoo dolerites are of no palaeontological significance
Duration	The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent
Cumulative effect	Low Cumulative Impact The cumulative effect of the development area within the proposed location is considered to be moderate. The broader area near Loeriesfontein is underlain by the Dwyka Group (low Palaeontological Sensitivity) and Ecca Group of the Karoo Supergroup. This include the Prince Albert (high

	Palaeontological Sensitivity), Whitehill and Tierberg with a moderate Palaeontological Sensitivity. Permian and Jurassic bedrocks are covered with a range of superficial deposits generally of low palaeontological sensitivity. The intrusive Karoo dolerites are of no palaeontological significance	
Intensity/magnitude	Probable significant impacts on palaeontological heritage during the construction phase are high (Prins Albert Formation), and the intensity of the impact on fossil heritage is rated as high	
Significance Rating	*A brief description of the importance of an impact which in turn dictates the level of mitigation required*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	1
Reversibility	1	1
Irreplaceable loss	3	1
Duration	4	1
Cumulative effect	4	1
Intensity/magnitude	3	1
Significance rating	-48 (negative medium)	-6 (negative low)
Mitigation measures	Suggested mitigation of the predictable damage and destruction of fossil within the proposed development area would involve the description and collecting of fossils within the development footprint by a professional palaeontologist. This work should take place after initial vegetation clearance but *prior to* ground levelling for construction Impacts on fossil heritage are usually irreversible. And thus well-documented records and additional palaeontological studies of fossils exposed through construction would characterise a positive impact scientifically. The probability of a negative impact on the palaeontological heritage of the area can be reduced by the execution of suitable damage mitigation procedures. If damage mitigation is correctly undertaken the benefit scale for the project will lie within the beneficial category. A site visit to the Prince Albert Formation would provide information on the presence of fossil Heritage	

Table 5: Impact rating – Heritage resources

IMPACT TABLE	
Environmental Parameter	Heritage resources
Issue/Impact/Environmental Effect/Nature	Heritage Resources have been identified during the fieldwork having low archaeological significance. All the identified find spots could be impacted by construction activities however the impact is seen as negligible.
Extent	Localised
Probability	Probable
Reversibility	Non- renewable.
Irreplaceable loss of resources	Archaeological sites are irreplaceable
Duration	Permanent
Cumulative effect	Low cumulative impact
Intensity/magnitude	Medium

Significance Rating	Negative medium impact before mitigation and low negative after mitigation.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	3	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	3	1
Intensity/magnitude	2	1
Significance rating	-40 (Negative Medium Impact	-16 (Low negative
Mitigation measures	A walk down of the final layout to determine if any significant sites will be affected. Monitor find spot areas if construction is going to take place through them. A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations. Possible surface collections for sites with a medium to high significance as well as conducting a watching brief by heritage practitioner during the construction phase.	

Table 6: Impact rating – chance finds

IMPACT TABLE		
Environmental Parameter	Unidentified heritage structures	
Issue/Impact/Environmental Effect/Nature	Due to the size of the area assessed and the design process requiring fieldwork before identification of the layout. The possibility of encountering heritage features in unsurveyed areas does exist.	
Extent	Localised and in most cases no more than $1000m^2$	
Probability	Probable	
Reversibility	Heritage resources are non-renewable.	
Irreplaceable loss of resources	A brief description of the degree in which irreplaceable resources are likely to be lost	
Duration	Permanent	
Cumulative effect	Medium	
Intensity/magnitude	Medium	
Significance Rating	Medium negative before mitigation and low negative after mitigation for both the expanded and the constrained layout.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	3
Reversibility	4	4
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	3	3
Intensity/magnitude	2	1
Significance rating	-34 (Medium negative)	-17 (Low negative)
	Post mitigation impact rating	

Mitigation measures	A walk down of the final approved layout will be required before construction commence; Any heritage features of significance identified during this walk down will require formal mitigation or where possible a slight change in design could accommodate such resources. A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.

6.2 Confidence in Impact Assessment

It is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some heritage sites.

The impact assessment conducted for heritage sites assumes the possibility of finding heritage resources during the project life and has been conducted as such.

6.3 Cumulative Impacts

This section evaluates the possible cumulative impacts (CI) on heritage resources with the addition of the Xha! Boom WEF grid connection and substation. The CI on heritage resources evaluated a 30-kilometer radius (**Figure 12**). It must further be noted that the evaluation is based on available heritage studies and cannot take the findings of outstanding studies on current ongoing EIA's in consideration.

The following must be considered in the analysis of the cumulative effect of development on heritage resources:

- **Fixed datum or dataset:** There is no comprehensive heritage data set for the Copperton region and thus we cannot quantify how much of a specific cultural heritage element is present in the region. The region has never been covered by a heritage resources study that can account for all heritage resources. Further to this none of the heritage studies conducted can with certainty state that all heritage resources within the study area has been identified and evaluated;
- **Defined thresholds**: The value judgement on the significance of a heritage site will vary from individual too individual and between interest groups. Thus implicating that heritage resources' significance can and does change over time. And so will the tipping threshold for impacts on a certain type of heritage resource;
- **Threshold crossing**: In the absence of a comprehensive dataset or heritage inventory of the entire region we will never be able to quantify or set a threshold to determine at what stage the impact from developments on heritage resources has reached or is reaching the danger level or excludes the new development on this basis. (Godwin, 2011)

Keeping the above short comings in mind, the methodology in evaluating cumulative impacts on heritage resources will be followed for the Impact Assessment phase.

The analysis of the competed studies as listed below (**Figure 12**), taking in to account the findings and recommendation of each of the nine evaluated HIA's.

- MORRIS, DAVID. 2007. Archaeological Specialist input with respect to the upgrading railway infrastructure on the Sishen-Saldanha ore line in the vicinity of Loop 7a near Loeriesfontein. McGregor Museum.
- FOURIE, WOUTER. 2011. Heritage Impact Assessment for the proposed Solar Project on the farm Kaalspruit, Loeriesfontein. PGS Heritage and Grave Relocation Consultants.
- ALMOND, J.E. 2011. Palaeontological Desktop Study for the Proposed Mainstream Wind Farm Near Loeriesfontein, Namaqua District Municipality, Northern Cape Province.
- VAN SCHALKWYK, J. 2011. Heritage Impact Assessment for the proposed establishment of a wind farm and PV facility by Mainstream Renewable Power in the Loeriesfontein Region, Northern Cape Province.
- VAN DER WALT, JACO. 2012. Archaeological Impact Assessment for the proposed Hantam PV Solar Energy Facility on the farm Narosies 228, Loeriesfontein, Northern Cape Province.
- WEBLEY, L & HALKETT, D. 2012. Heritage Impact Assessment: Proposed Loeriesfontein Photo-Voltaic Solar Power Plant On Portion 5 of the Farm Klein Rooiberg 227, Northern Cape Province.
- MORRIS, DAVID. 2013. Specialist Input for the Environmental Basic Assessment and Environmental Management Program for the Khobab Wind Energy Facility: Power Line Route Options, Access Road And Substation Positions.
- ORTON, JAYSON. 2014. Heritage Impact Assessment for the proposed re-alignment of the authorized 132kV Power Line for the Loeriesfontein 2 WEF, Calvinia Magisterial District, Northern Cape.
- Fourie, W. 2015. Heritage Impact Assessment for the proposed establishment of the Dwarsrug wind farm and PV facility in the Loeriesfontein Region, Northern Cape Province.

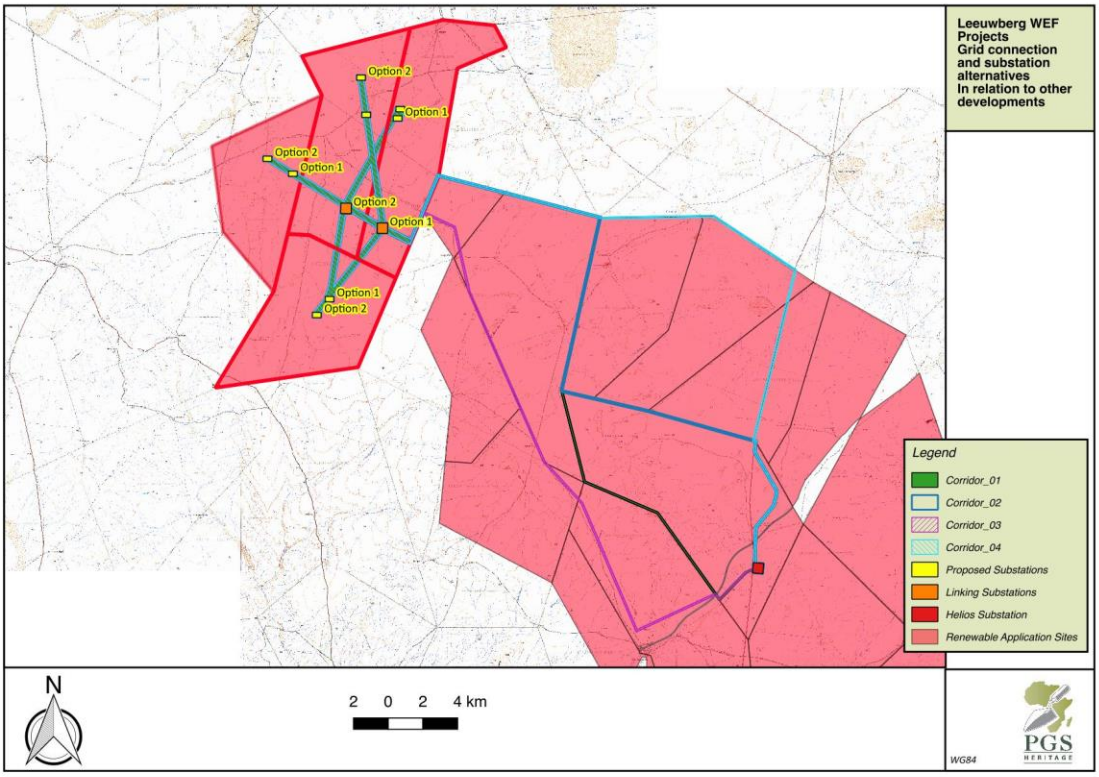

Figure 12: Other RE developments in relation to the Xha! Boom Wind Farm application area

Table 7: Impact rating – Cumulative

IMPACT TABLE	
Environmental Parameter	Heritage Resources
Issue/Impact/Environmental Effect/Nature	The extent that the addition of this project will have on the overall impact of developments in the region on heritage resources
Extent	Local
Probability	Possible
Reversibility	Non- renewable.
Irreplaceable loss of resources	The nature of heritage resources are that they are non-renewable. The proper mitigation and documentation of these resources can however preserve the data for research
Duration	Permanent
Cumulative effect	It is my reserved but considered opinion that this additional load on the overall impact on heritage resources will be low. With a detailed and comprehensive regional dataset this rating could possibly be adjusted and more accurate.
Intensity/magnitude	Low
Significance Rating	Negative low impact before mitigation and low negative after mitigation.

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	2
Probability	2	1
Reversibility	4	4
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	1	1

Intensity/magnitude	1	1
Significance rating	-18 (Negative medium impact)	-18 (Low negative)
Mitigation measures	A walk down of the final approved layout will be required before construction commence; Any heritage features of significance identified during this walk down will require formal mitigation or where possible a slight change in design could accommodate such resources. A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations.	

It is my considered opinion that this additional load on the overall impact on heritage resources will be low. With a detailed and comprehensive regional dataset this rating could possibly be adjusted and more accurate.

6.4 Reversibility of Impacts

Although heritage resources are seen as non-renewable the mitigation of impacts on possible finds through scientific documentation will provided sufficient mitigation on the impacts on possible heritage resources.

6.5 Assessment of alternatives

It should be noted that two (2) alternative sites for the proposed on-site Xha! Boom Substation and the proposed Linking Substation have been assessed during the Basic Assessment (BA), in conjunction with four (4) power line corridor alternatives.

The fieldwork and site analysis of the various alternatives indicates that all four corridor alternatives between substation option 1 and linking substation option 1 impact on a low significance heritage sites **XHA003**. The heritage site is of low significance and the impact is also judged as being of low negative significance. No further mitigation or re-routing within the corridor alternatives will be required.

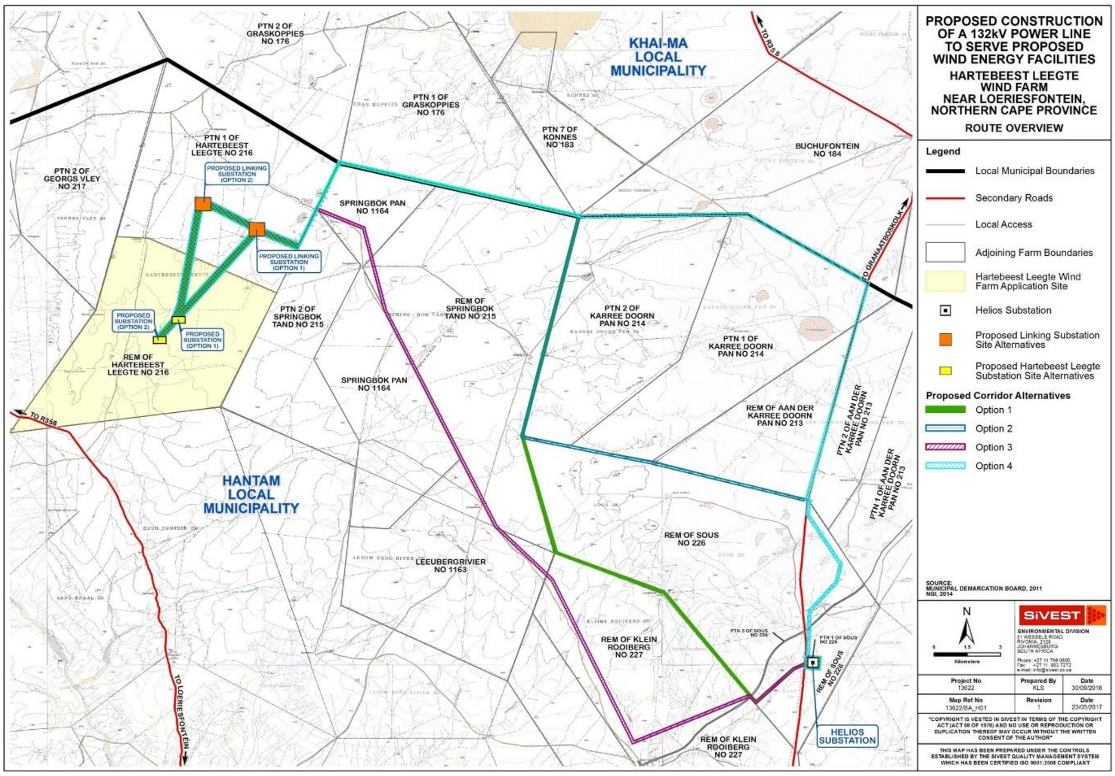

Figure 13: Site Locality Map

Key

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Xha! Boom Grid Connection

Alternative	Preference	Reasons (incl. potential issues)
SUBSTATION ALTERNATIVES		
On-site Substation Option 1	**NO PREFERENCE**	No heritage resources were identified that can potentially be impacted by this option locality
On-site Substation Option 2	**NO PREFERENCE**	A single low significance heritage resources was identified in the footprint area. The impact is however low negative and negligible.
Linking Substation Option 1	**NO PREFERENCE**	No heritage resources were identified that can potentially be impacted by this option locality

Alternative	Preference	Reasons (incl. potential issues)
Linking Substation Option 2	**NO PREFERENCE**	No heritage resources were identified that can potentially be impacted by this option locality
GRID LINE CORRIDOR ALTERNATIVES		
Grid Line Option 1	**FAVOURABLE**	No heritage resources were identified that can potentially be impacted by this alignment
Grid Line Option 2	**FAVOURABLE**	No heritage resources were identified that can potentially be impacted by this alignment
Grid Line Option 3	**FAVOURABLE**	No heritage resources were identified that can potentially be impacted by this alignment
Grid Line Option 4	**FAVOURABLE**	No heritage resources were identified that can potentially be impacted by this alignment

7 CONCLUSIONS AND RECOMMENDATIONS

PGS was appointed by SiVEST Environmental Division (SiVEST) to undertake an HIA that forms part of the BAR and EMP for the Xha! Boom WEF 132kV grid connection and substation for South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream), near Loeriesfontein in the Northern Cape Province.

Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as significant.

The background research completed in October 2016 has shown that the proposed Xha! Boom WEF grid connection and substation to be developed as a WEF may have heritage resources present on the property. This has been confirmed through archival research and evaluation of aerial photography of the sites.

The subsequent field work completed for the October 2016 and June 2017, has confirmed the presence of 1 heritage resource (XHA003) as well as several areas with existing infrastructure such as fenced off camps, windmills and reservoirs.

7.1 Impact and Cumulative Impact

Only one low significance identified heritage resources is affected by the proposed grid connection and substation layout. The impact by the proposed development on heritage resources will be low to negligible.

It is my considered opinion that this additional load on the overall impact on heritage resources will have a low to negligible cumulative impact.

None of the alternatives are deemed to be unfavourable and all can be utilised from a heritage point of view.

7.2 Mitigation

The design process and methodology followed by the developer for this project will enabled the heritage assessment to provide input into the proposed layouts. This resulted in cognisance being taken of the positions of the heritage resources and thus the reduction of impacts at an early design phase

The mitigation measures proposed is a follows:

7.3 Pre-Construction

4. A walk down of the final layout to determine if any significant sites will be affected.
5. Monitor find spot areas if construction is going to take place through them.
6. A management plan for the heritage resources needs then to be compiled and approved for implementation during construction and operations. Possible surface collections for sites with a medium to high significance as well as conducting a watching brief by heritage practitioner during the construction phase.
7. Avoid the historical farmstead at BHL001

7.4 Palaeontology

The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian rocks of the lower part of the Ecca Group (Karoo Supergroup). This include the Prince Albert, Whitehill and Tierberg Formations. Permian and Jurassic bedrocks are covered with a range of superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age.

The Permo-Carboniferous Dwyka Group is known for its track ways that was mostly formed by fish and arthropods (invertebrates) as well as fossilized faeces (coprolites). Fossils other than trace assemblages are generally uncommon and most of the Dwyka sediments are of low overall palaeontological sensitivity. When body fossils do occur it is of marine fish, gastropods and invertebrates as well as fossil plants, spores and pollens.

The fossil assemblage of the **Prince Albert Formation** consists basically of trace fossils, whereas plant fossils are found in large quantities in the sandstone rich sections in the northern parts of the Basin. The trace fossil assemblage of the non-marine *Mermia* Ichnofacies, is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails) and are normally found in basinal mudrock facies of the Prince Albert Formation.

Fossil Heritage of the **Whitehill Formation** includes mesosaurid reptiles, palaeoniscoid fish, small eocarid crustaceans, insects, and trace fossils of king crab as well as possible shark coprolites, palynomorphs, petrified wood (mainly of primitive gymnosperms, silicified or calcified) and rare vascular plant remains.

The fossil assemblage of the **Tierberg Formation** comprise of disarticulated micro vertebrate remains (e.g. fish teeth, scales) sponge remains, rare vascular plants (leaves and petrified wood) with a medium diversity of trace fossil assemblages.

The Karoo Dolerite Suite consists of igneous rocks and are unfossiliferous. Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil biotas. Fossils assemblages may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells and freshwater stromatolites are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

According to the SAHRIS PlaeoMap the Dwyka Group has a low Palaeontological Sensitivity while the Ecca Group (Tierberg and Whitehill Fromations) has a moderate palaeontological Sensitivity. But, the Palaeontological Sensitivity of the Prince Albert Formation is High and thus a site visit is recommended.

Prior to construction a detailed palaeontology study will thus be conducted to assess the value and importance of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the detailed Report is to elaborate on the issues and potential impacts identified during the initial study undertaken for the Basic Assessment (BA). This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the BA. The report will be submitted to SAHRA before the commencement of any development-related activities.

8 REFERENCES

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Appendix A

LEGISLATIVE PRINCIPLES

LEGISLATIVE REQUIREMENTS – TERMINOLOGY AND ASSESSMENT CRITERIA

3.1 General principles

In areas where there has not yet been a systematic survey to identify conservation worthy places, a permit is required to alter or demolish any structure older than 60 years. This will apply until a survey has been done and identified heritage resources are formally protected.

Archaeological and palaeontological sites, materials, and meteorites are the source of our understanding of the evolution of the earth, life on earth and the history of people. In the new legislation, permits are required to damage, destroy, alter, or disturb them. People who already possess material are required to register it. The management of heritage resources are integrated with environmental resources and this means that before development takes place heritage resources are assessed and, if necessary, rescued.

In addition to the formal protection of culturally significant graves, all graves, which are older than 60 years and are not in a cemetery (such as ancestral graves in rural areas), are protected. The legislation protects the interests of communities that have interest in the graves: they may be consulted before any disturbance takes place. The graves of victims of conflict and those associated with the liberation struggle will be identified, cared for, protected and memorials erected in their honour.

Anyone who intends to undertake a development must notify the heritage resource authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the developer's cost. Thus, developers will be able to proceed without uncertainty about whether work will have to be stopped if an archaeological or heritage resource is discovered.

According to the National Heritage Act (Act 25 of 1999 section 32) it is stated that:
An object or collection of objects, or a type of object or a list of objects, whether specific or generic, that is part of the national estate and the export of which SAHRA deems it necessary to control, may be declared a heritage object, including –

- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects, meteorites and rare geological specimens;
- visual art objects;
- military objects;
- numismatic objects;
- objects of cultural and historical significance;
- objects to which oral traditions are attached and which are associated with living heritage;
- objects of scientific or technological interest;
- books, records, documents, photographic positives and negatives, graphic material, film or video or sound recordings, excluding those that are public records as defined in section 1 (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996), or in a provincial law pertaining to records or archives; and
- any other prescribed category.

Under the National Heritage Resources Act (Act No. 25 of 1999), provisions are made that deal with, and offer protection, to all historic and pre-historic cultural remains, including graves and human remains.

3.2 Graves and cemeteries

Graves younger than 60 years fall under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the Office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning, or in some cases the MEC for Housing and Welfare. Authorisation for exhumation and reinterment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. In order to handle and transport human remains the institution conducting the relocation should be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

Graves older than 60 years, but younger than 100 years fall under Section 36 of Act 25 of 1999 (National Heritage Resources Act) as well as the Human Tissues Act (Act 65 of 1983) and are the jurisdiction of the South African Heritage Resource Agency (SAHRA). The procedure for Consultation Regarding Burial Grounds and Graves (Section 36(5) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in the category located inside a formal cemetery administrated by a local authority will also require the same authorisation as set out for graves younger than 60 years over and above SAHRA authorisation.

If the grave is not situated inside a formal cemetery but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws set by the cemetery authority must be adhered to.

Appendix B

Heritage Assessment Methodology

The section below outlines the assessment methodologies utilised in the study.

The Heritage Impact Assessment (HIA) report to be compiled by PGS Heritage (PGS) for the proposed Xha! Boom WEF will assess the heritage resources found on site. This report will contain the applicable maps, tables and figures as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998) and the Minerals and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consists of three steps:

Step I – Literature Review: The background information to the field survey leans greatly on the Heritage Scoping Report completed by PGS for this site.

Step II – Physical Survey: A physical survey was conducted on foot and by vehicle through the proposed project area by qualified archaeologists, aimed at locating and documenting sites falling within and adjacent to the proposed development footprint.

Step III – The final step involved the recording and documentation of relevant archaeological resources, as well as the assessment of resources in terms of the heritage impact assessment criteria and report writing, as well as mapping and constructive recommendations

The significance of heritage sites was based on four main criteria:

- **site integrity** (i.e. primary vs. secondary context),
- **amount of deposit, range of features** (e.g., stonewalling, stone tools and enclosures),
    - Density of scatter (dispersed scatter)
        - Low - $<10/50m^2$
        - Medium - $10\text{-}50/50m^2$
        - High - $>50/50m^2$
- uniqueness and
- **potential** to answer present research questions.

Management actions and recommended mitigation, which will result in a reduction in the impact on the sites, will be expressed as follows:

A - No further action necessary;

B - Mapping of the site and controlled sampling required;

C - No-go or relocate pylon position

D - Preserve site, or extensive data collection and mapping of the site; and

E - Preserve site

Site Significance

Site significance classification standards prescribed by the South African Heritage Resources Agency (2006) and approved by the Association for Southern African Professional Archaeologists (ASAPA) for the Southern African Development Community (SADC) region, were used for the purpose of this report.

Table 1: Site significance classification standards as prescribed by SAHRA

FIELD RATING	GRADE	SIGNIFICANCE	RECOMMENDED MITIGATION
National Significance (NS)	Grade 1	-	Conservation; National Site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; Provincial Site nomination
Local Significance (LS)	Grade 3A	High Significance	Conservation; Mitigation not advised
Local Significance (LS)	Grade 3B	High Significance	Mitigation (Part of site should be retained)
Generally Protected A (GP.A)		High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)		Medium Significance	Recording before destruction
Generally Protected C (GP.A)		Low Significance	Destruction

Appendix C

Impact Assessment Methodology to be utilised during EIA phase

1 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

1.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 3.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

1.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

1.2.1 Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.

2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		

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

SIGNIFICANCE

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

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

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

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.

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

Appendix D

Palaeontological Desktop Assessment

PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF FOUR LEEUWBERG WIND FARMS AND BASIC ASSESSMENTS FOR THE ASSOCIATED GRID CONNECTION NEAR LOERIESFONTEIN, NORTHERN CAPE PROVINCE

Prepared for:

PGS Heritage

Revision 2

14-02-2018

Prepared by

BANZAI ENVIRONMENTAL (PTY) LTD

EXECUTIVE SUMMARY

Banzai Environmental was appointed by PSG Heritage to conduct the EIA Report for the proposed development of four Leeuwberg Wind Farms near Loeriesfontein in the Northern Cape Province. The proposed development will consist of four wind farms namely Hartebeesleegte, Graskoppies, Itemba and !Xha Boom Wind Farm and associated infrastructure as well as 4 Grid Connection Corridors alternatives. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the four wind farms on the palaeontological resources.

The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian rocks of the lower part of the Ecca Group (Karoo Supergroup). This include the Prince Albert, Whitehill and Tierberg Formations. Permian. The Jurassic bedrocks are covered with a range of superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age.

According to the SAHRIS PlaeoMap the Dwyka Group has a low Palaeontological Sensitivity while the Ecca Group (Tierberg and Whitehill Fromations) has a moderate palaeontological Sensitivity. But, the Palaeontological Sensitivity of the Prince Albert Formation is High. The Karoo Dolerite Suite consists of igneous rocks and are unfossiliferous. Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. Due to the High Palaeontological sensitivity of the Prince Albert Formation (Ecca Group) a site visit is thus recommended.

Prior to construction a detailed palaeontology study will thus be conducted to assess the value and importance of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the detailed Report is to elaborate on the issues and potential impacts identified during the initial study undertaken for the Basic Assessment (BA). This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the BA. The report will be submitted to SAHRA before the commencement of any development-related activities.

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2 INTRODUCTION

Mainstream appointed SiVEST, as the independent Environmental Assessment Practitioner, to undertake the required Basic Assessment processes for the proposed construct of four Leeuwberg Wind Farms near Loeriesfontein in the Northern Cape Province (Fig.1). The proposed new developments are:

- 140MW Graskoppies Wind Farm and Grid Connection
- 140MW !Xha Boom Wind Farm and Grid Connection
- 140MW Hartebeesleegte Wind Farm and Connection
- 140MW Itemba Wind Farm and Grid Connection

Additionally, the South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream), are proposing the construction of four 132kV power lines, four 33kV/132kV on-site substations and a 132kV Linking Substation, to connect the proposed wind farms to the national grid at Helios Substation. In order to accommodate the Department of Energy's competitive bidding process for procuring renewable energy from Independent Power Producers in South Africa, each wind farm will require a separate Environmental Authorisation and each grid connection will also require a separate Environmental Authorisation.

Both Environmental Impact and Basic Assessments will be conducted in terms of the EIA Regulations (2014) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). According to these regulations, Environmental Impact Assessments will be necessary for the proposed wind farms and Basic Assessments will be required for the associated grid connections. Thus, four EIAs will be undertaken, one for each proposed wind farm as well as four Basic Assessments, one for each associated grid connection. Even though each wind farms and associated grid connection will be assessed separately, a single public participation process is being undertaken for all eight proposed projects.

3 WIND ENERGY

3.1 Benefits (Information Provided By Sivest)

The growing demand for energy and present electricity shortages as well as the need to find more sustainable and environmentally friendly energy resources, South Africa has embarked on an infrastructure growth programme supported by various government initiatives. In reaction to this goal; Mainstream are recommending to develop the four Leeuwberg Wind Farms, associated infrastructure and four grid connections near Loeriesfontein in the Northern Cape Province.The overall objective of the project is to generate electricity, by means of renewable energy technologies, to feed into the national grid at Helios Substation.

- Wind energy is renewable, clean and non-polluting (greenhouse gases etc.), and does not produce by-products (atmospheric contaminants or thermal pollution) that could be detrimental to the environment;
- Wind farms are usually well suited to rural areas and therefore have a reduced impact on agriculture compared to other electricity generating options. Wind turbines can also contribute to economic growth in these areas;
- Wind turbines make use of comparatively simple technology in terms of design and construction;
- Wind energy is competitively priced compared to other renewable energy sources;
- Localised production of energy reduces transmission line losses associated with transmitting electricity over long distances;
- The use of wind turbines reduces the use of coal and other fossil fuels with their associated emissions of greenhouse gases; and
- Wind farms improve energy security for South Africa, reducing dependency on fossil fuels

Wind turbines are mounted onto a tower to confine wind energy. The kinetic energy generated by the wind turn the blades of the turbines to generate electricity. The wind turbines are erected at a height of up to 150m above the ground and take advantage of the fastest and less turbulent wind. Usually, 2 to 3 blades are mounted on a shaft to form a rotor. The nacelle sits on top of the hub and contains the generator, control equipment, gearbox and anemometer for monitoring the wind speed and direction. The mechanical power generated through the rotating blades is transmitted to the generator via a gear box and drive train which converts the turning motion of the blades into electricity.

Wind turbines are generally designed to operate continuously for more than 20 years with minimal maintenance. A wind energy facility can be monitored and controlled remotely with a mobile team for maintenance when required.

3.2 Technical Details

At this stage each proposed wind farm, consisting of the turbines and associated infrastructure, will have a total generation capacity of 140MW. The number of wind turbines will be determined during the EIA process. The generated electricity will be fed into the national grid at the Helios Substation via a 132kV power line.

The size of the wind turbines will depend on the developable area and the total generation capacity that can be produced as a result. The wind turbines will therefore have a hub height of up to 150m and a rotor diameter of up to 150m. The blade rotation direction will depend on wind measurement information received later in the process. The electrical generation capacity for each turbine will range from 1.5 to 4MW depending on the final wind turbine selected for the proposed development.

3.3 Wind Farm Electrical Infrastructure

The wind turbines will be connected to the substation using buried (up to a 1,5m depth) medium voltage cables except where a technical assessment of the proposed design suggests that overhead lines are appropriate, such as over rivers and gullies. Where overhead power lines are to be constructed, monopole tower structures will be used in combination with the steel lattice towers at bend points. The dimensions of the monopole structures will depend on grid safety requirements and the grid operator. The exact location of the towers and the final design will depend on Eskom requirements. The proposed wind farm will connect to the national grid at Helios substation via a 132kV power line with a length of up to 48km.

A new substation and associated transformers will be developed which will supply the generated electricity to the national grid. The connection from the substation to the national grid line will be an overhead power line.

3.3.1 Roads

Access roads width and location will be determined during the Environmental Impact Assessment and Basic Assessment processes.

3.3.2 Construction Lay Down Area

A temporary lay down area will be constructed for the proposed development and will include an access road and a contractor’s site office

Other infrastructure includes:

- Operation and maintenance (O&M) buildings;
- Fencing; and
- Linking station.

Should more than one wind farm receive an EA and a license from the DoE the option of sharing the Linking Station and 132kV power line will be considered.

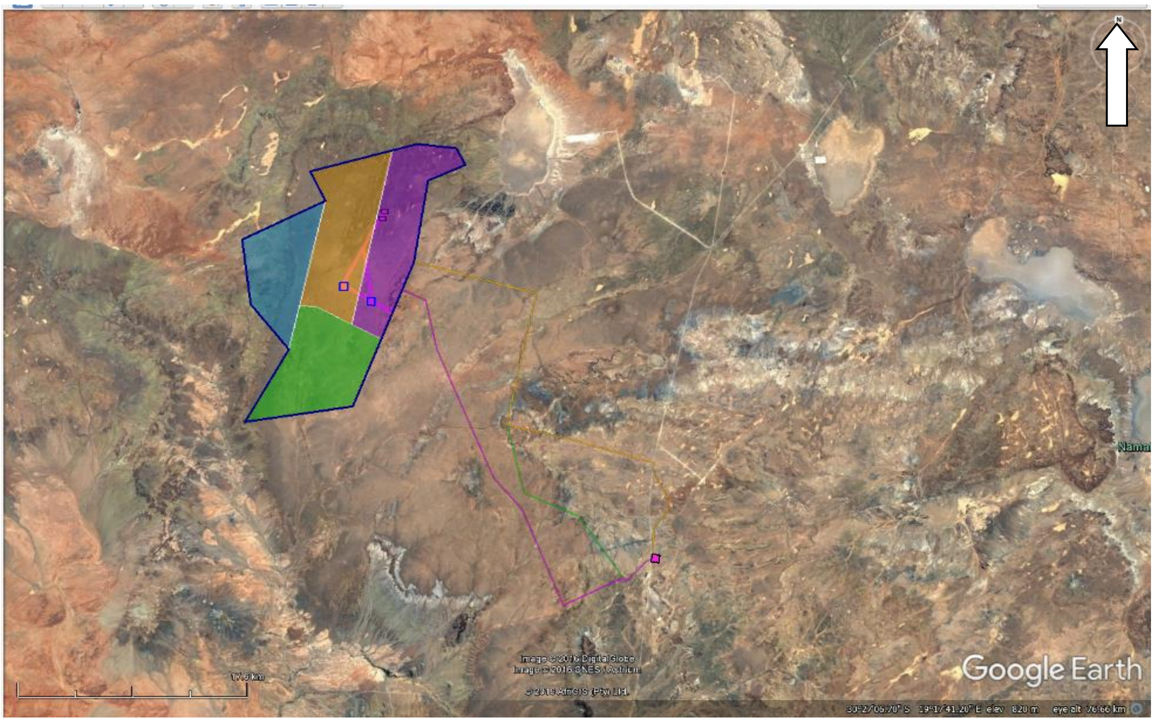

Figure 1. Google Earth image (2016) of the proposed location of the four Leeuwberg Wind Farms near Loeriesfontein in the Northern Cape Province.

4 LEGISLATION

4.1 General Management Guidelines

1. The National Heritage Resources Act (Act 25 of 1999) states that, any person who intends to undertake a development categorised as-

(a) the construction of a road, wall, transmission line, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;

(b) the construction of a bridge or similar structure exceeding 50m in length;

(c) any development or other activity which will change the character of a site-

  (i) exceeding 5 000 m^2 in extent; or

  (ii) involving three or more existing erven or subdivisions thereof; or

  (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

  (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA.SAHRA;

(d) the re-zoning of a site exceeding 10 000 m^2 in extent; or

(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

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

5 OBJECTIVE

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

According to the “SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports” the aims of the palaeontological impact assessment are: 1) to identify the palaeontological importance of the exposed and subsurface rock formations in the development footprint 2) to evaluate the palaeontological importance of the formations 3) to determine the impact of the development on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontological desktop study is compiled, the potentially fossiliferous rocks (i.e. groups, formations, etc.) present within the study area are established from 1:250 000 geological maps. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within each rock section is obtained from previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations specifically in areas close to the development area). The palaeontological importance of each rock unit of the development area is then calculated. The possible impact of the proposed development footprint on local fossil heritage is established on the following criteria: 1) the palaeontological importance of the rocks and 2) the type and scale of the development footprint and 3) quantity of bedrock excavated.

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

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

6 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The development footprint (Fig.2-10) is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian basinal rocks of the lower part of the Ecca Group (Karoo Supergroup). They are assigned to the Prince Albert Formation, Whitehill Formation and Tierberg Formation in order of decreasing age. The Ecca Group were laid down surrounded by the marine to freshwater Ecca Sea.

These mudrocks are generally weathered, and forms landscapes of low relief. The Ecca Group sediments, and in particular the Whitehil Formation, are intruded by Early Jurassic (183 ± 2 Million years old) igneous intrusions of the Karoo Dolerite Suite (Duncan & Marsh 2006). These basic sills thermally metamorphosed or baked the neighbouring Ecca country rocks. The Permian and Jurassic bedrocks are in many areas mantled with a variety of superficial deposits, most of which is probably of Late Caenozoic (Quaternary to Recent) age. This include doleritic superficial rubble, gravelly to silty river alluvium and pan sediments and small patches of aeolian sands. The intrusive Karoo dolerites has no palaeontological significance and the Late Caenozoic superficial deposits are generally of low palaeontological sensitivity.

7 GEOLOGY

7.1 Dwyka Group

The Permo-Carboniferous Dwyka Group is the oldest deposit in the Karoo Supergroup. During the Dwyka, South Africa lie below a massive ice sheet and thus the Dwyka deposits were deposited in a cold, glacially-dominated environment. The Dwyka Group consists mainly of gravelly sediments with subordinate vorved shales and mudstones containing scraped and facetted pebbles. The retreating glaciers deposited dark-grey tillite. This Group is known for its rich assemblage of dropstones of various sizes.

7.2 Ecca Group

The Permian aged Ecca Group is undifferentiated and comprises of dark grey shale, mudstone and fine-grained sandstone (Johnson et al, 2006). The sedimentary rocks are severely weathered and mostly only exposed in deep excavations for road cuttings and quarries. The Ecca Group rocks are interpreted as a deep water deposit of silts and clays in the Ecca Sea.

The **Prince Albert Formation** consists of marine to hyposaline basin plain mudrocks with volcanic ashes, phosphates and iron stones, while post-glacial mudrocks has been identified from the base of the Prince Albert Formation. These sediments appear dark on satellite images since the outcrop is covered by gravels rich in ferromanganese minerals (Gravel clasts have a shiny-black patina of "desert varnish"). This section of Early Permian was previously known as the "Upper Dwyka Shales".

The **Whitehill Formation** consists of finely-laminated carbon-rich mudrocks of Early to Mid Permian age. These sediments were laid down about 278 Ma (million years ago) in a wide shallow, brackish to freshwater basin (Ecca Sea) that extended across southwestern Gondwana, from southern Africa into South America. Surface weathering of these highly-carbonaceous sediments produces pale grey to cream colours that are often seen in satellite images where the bedrock is exposed.

The **Tierberg Formation** is assumed to be offshore non-marine mudrocks with distal turbidite beds, prodeltaic sediments and consists of greenish weathering shale with subordinated siltstone and sandstone (Johnson et al, 2006).

7.3 Karoo Dolerite Suite

The Karoo Dolerite Suite were formed in the Early Jurassic Period (approximately 183 million years ago). The Karoo Dolerite Suite is a widespread system of igneous bodies (dykes, sills) that encroached into the sediments of the Main Karoo Basin. These igneous rocks are unfossiliferous.

7.4 Late Caenozoic superficial deposits

Various types of superficial deposits of Late Caenozoic (Miocene to Pliocene to Recent) age occur throughout the Karoo (Partridge *et al*. 2006). They include pedocretes (*e.g*..calcretes), colluvial slope deposits, down wasted surface gravels, river alluvium, wind-blown sands as well as spring and pan sediments. Karoo hill slopes are usually covered with a thin to thick layer of colluvium or slope deposits.

8 PALAEONTOLOGY

8.1 Dwyka Group

The Permo-Carboniferous Dwyka Group is known for its track ways that was mostly formed by fish and arthropods (invertebrates) as well as fossilized faeces (coprolites). Fossils other than trace assemblages are generally uncommon and most of the Dwyka sediments are of low overall palaeontological sensitivity. When body fossils do occur it is of marine fish, gastropods and invertebrates as well as fossil plants, spores and pollens.

8.2 Ecca Group

The fossil assemblage of the **Prince Albert Formation** consists basically of trace fossils, whereas plant fossils are found in large quantities in the sandstone rich sections in the northern parts of the Basin. The trace fossil assemblage of the non-marine *Mermia* Ichnofacies, is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails) and are normally found in basinal mudrock facies of the Prince Albert Formation.

Fossil Heritage of the **Whitehill Formation** includes mesosaurid reptiles, palaeoniscoid fish, small eocarid crustaceans, insects, and trace fossils of king crab as well as possible shark coprolites, palynomorphs, petrified wood (mainly of primitive gymnosperms, silicified or calcified) and rare vascular plant remains.

The fossil assemblage of the **Tierberg Formation** comprise of disarticulated micro vertebrate remains (e.g. fish teeth, scales) sponge spinucles, rare vascular plants (leaves and petrified wood) with a meduim diversity if trace fossil assemblages.

8.3 Karoo Dolerite Suite

The Karoo Dolerite Suite consists of igneous rocks and are unfossiliferous.

8.4 Late Caenozoic superficial deposits

Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil biotas. Fossils assemblages may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells and freshwater stromatolites are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

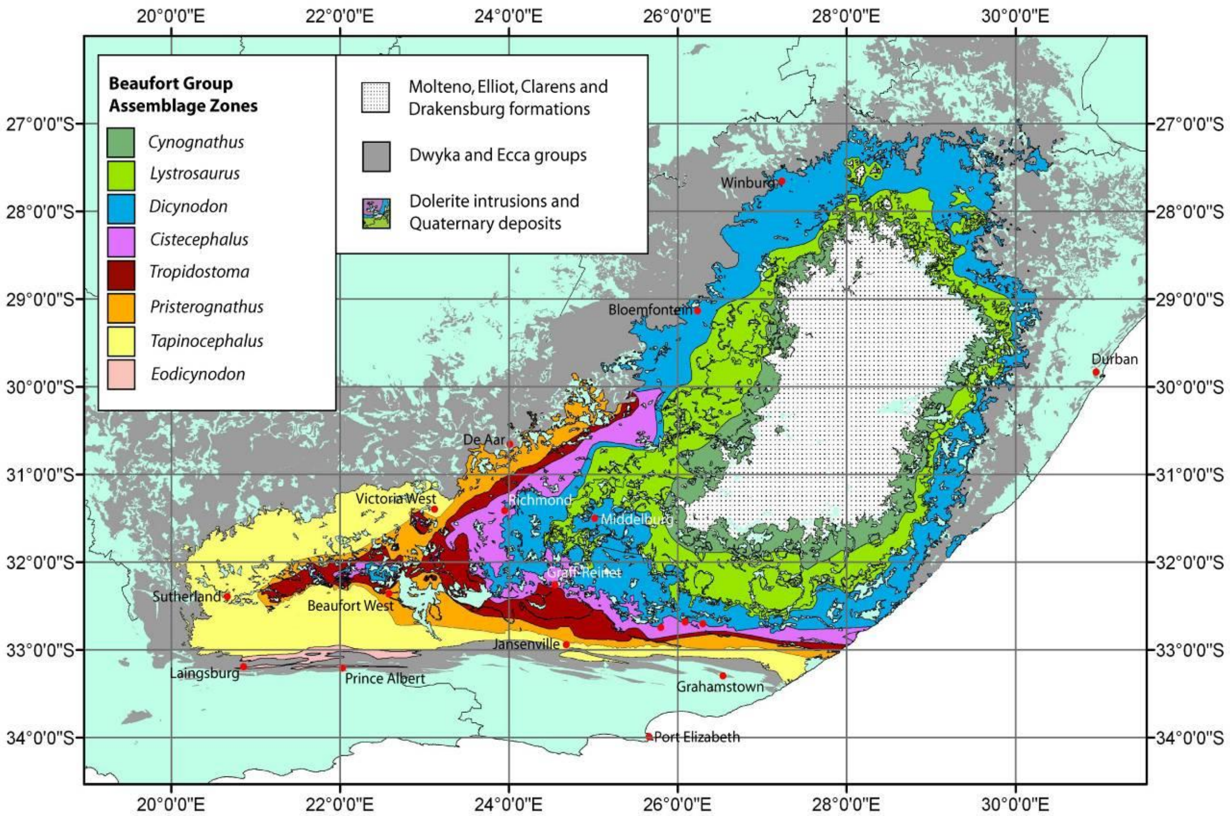

Figure 2. The surface geology of South Africa, as shown on the most recent fossil assemblage zone map for the Main Karoo Basin (Map modified from Van der Walt *et al.* 2010)

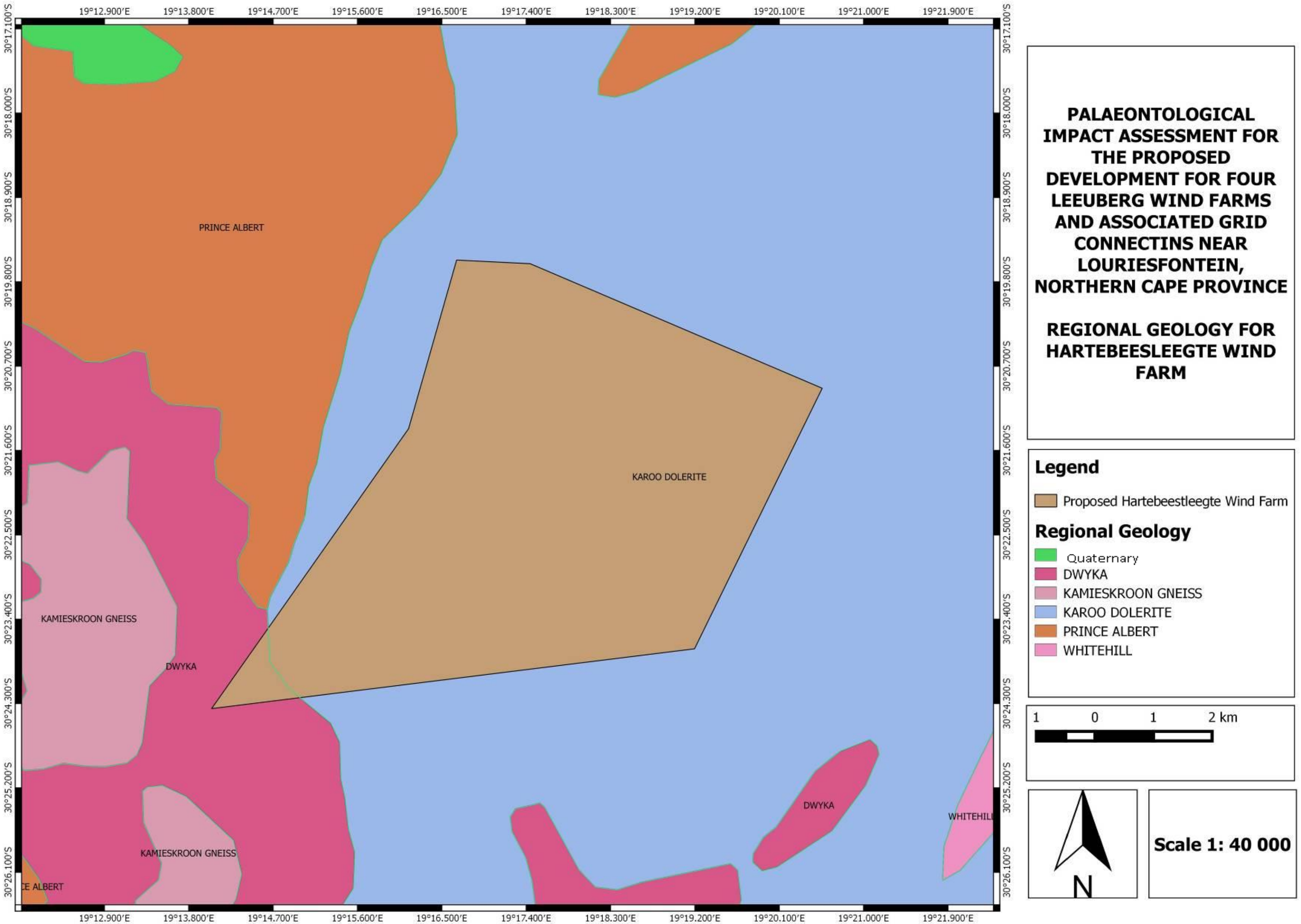

Figure 3. The surface geology of the proposed Hartebeesleegte Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is mostly underlain by Karoo Dolerite and a small area in the south west is underlain by the lowermost unit of the Karoo Supergroup, namely the Dwyka Group. Map drawn by QGIS.

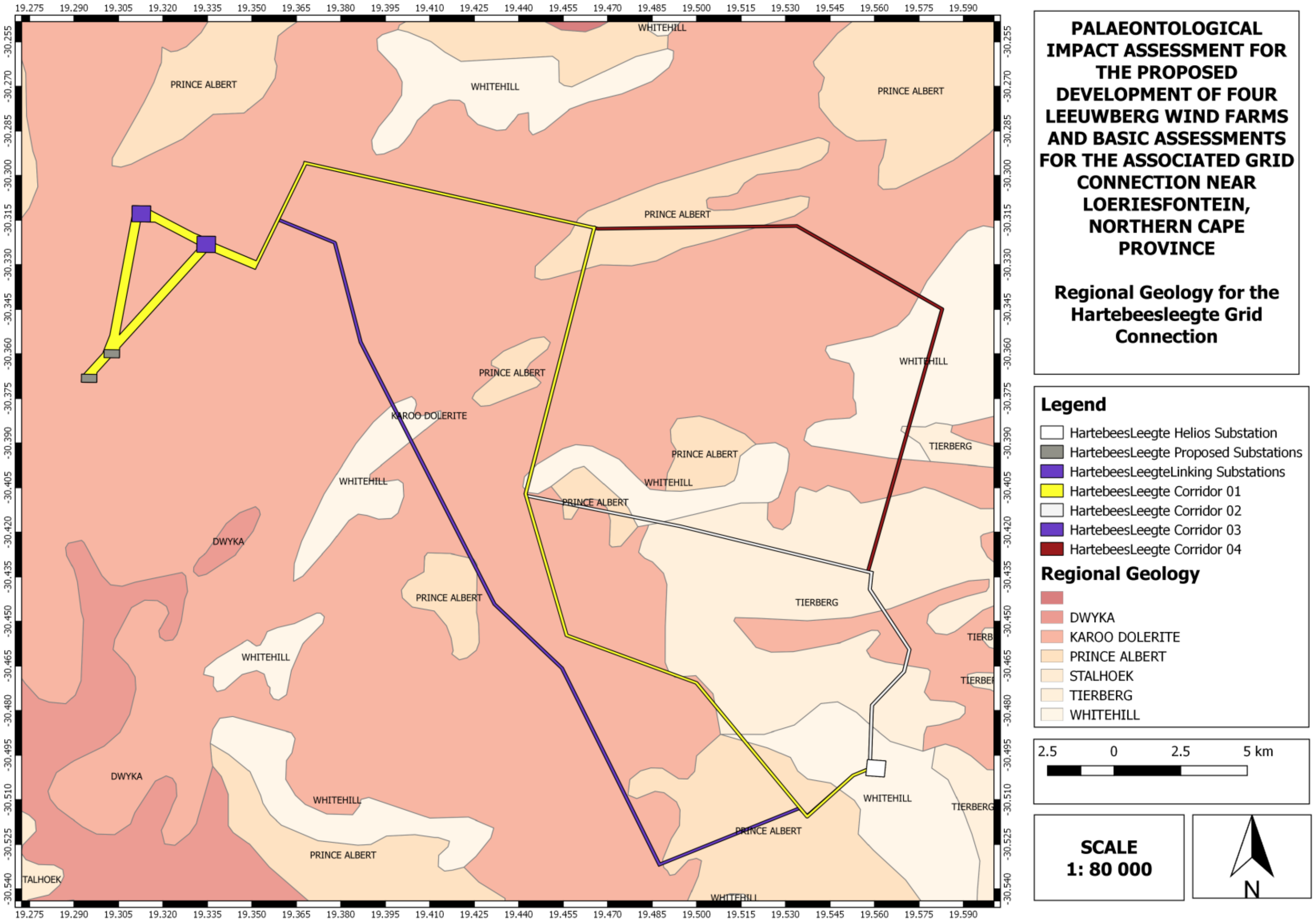

Figure 4. The surface geology of the proposed grid connection for the Hartebeesleegte Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert, Whitehill and Tierberg Formations of the Ecca Group. Map drawn by QGIS.

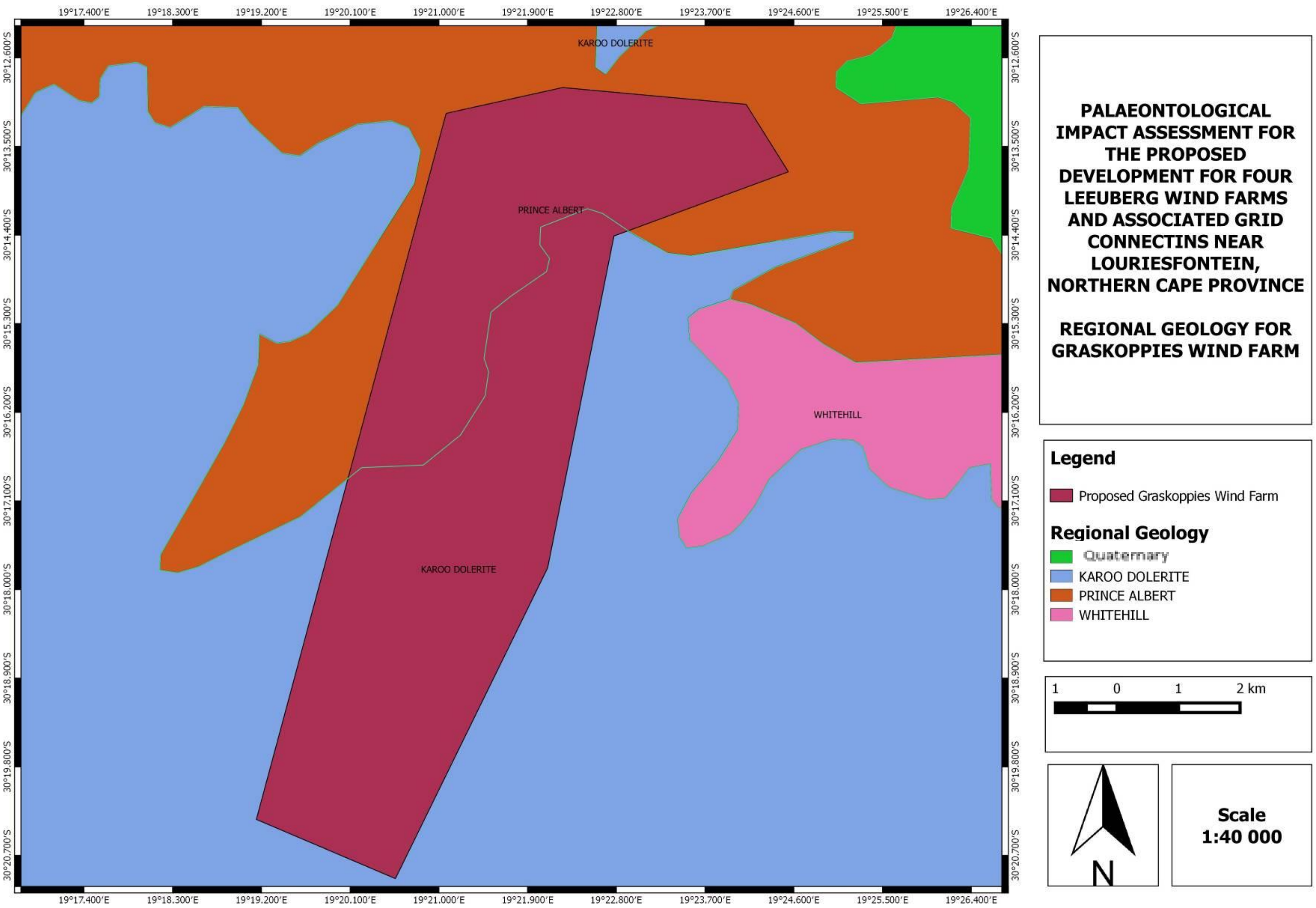

Figure 5. The surface geology of the proposed Graskoppies Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert and Whitehill Formations of the Ecca Group. Map drawn by QGIS.

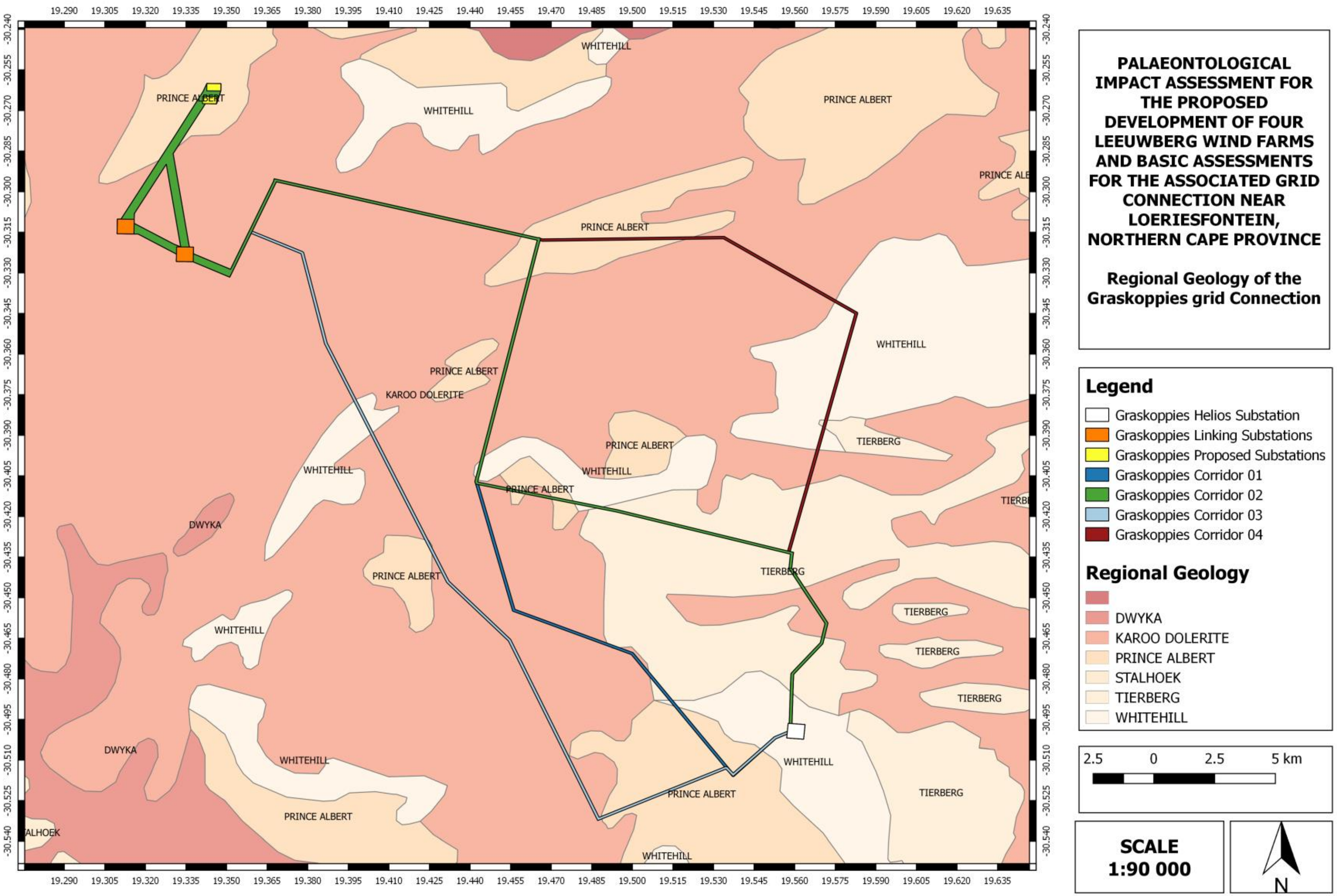

Figure 6. The surface geology of the proposed grid connection of Graskoppies Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert, Whitehill and Tierberg Formations of the Ecca Group. Map drawn by QGIS.

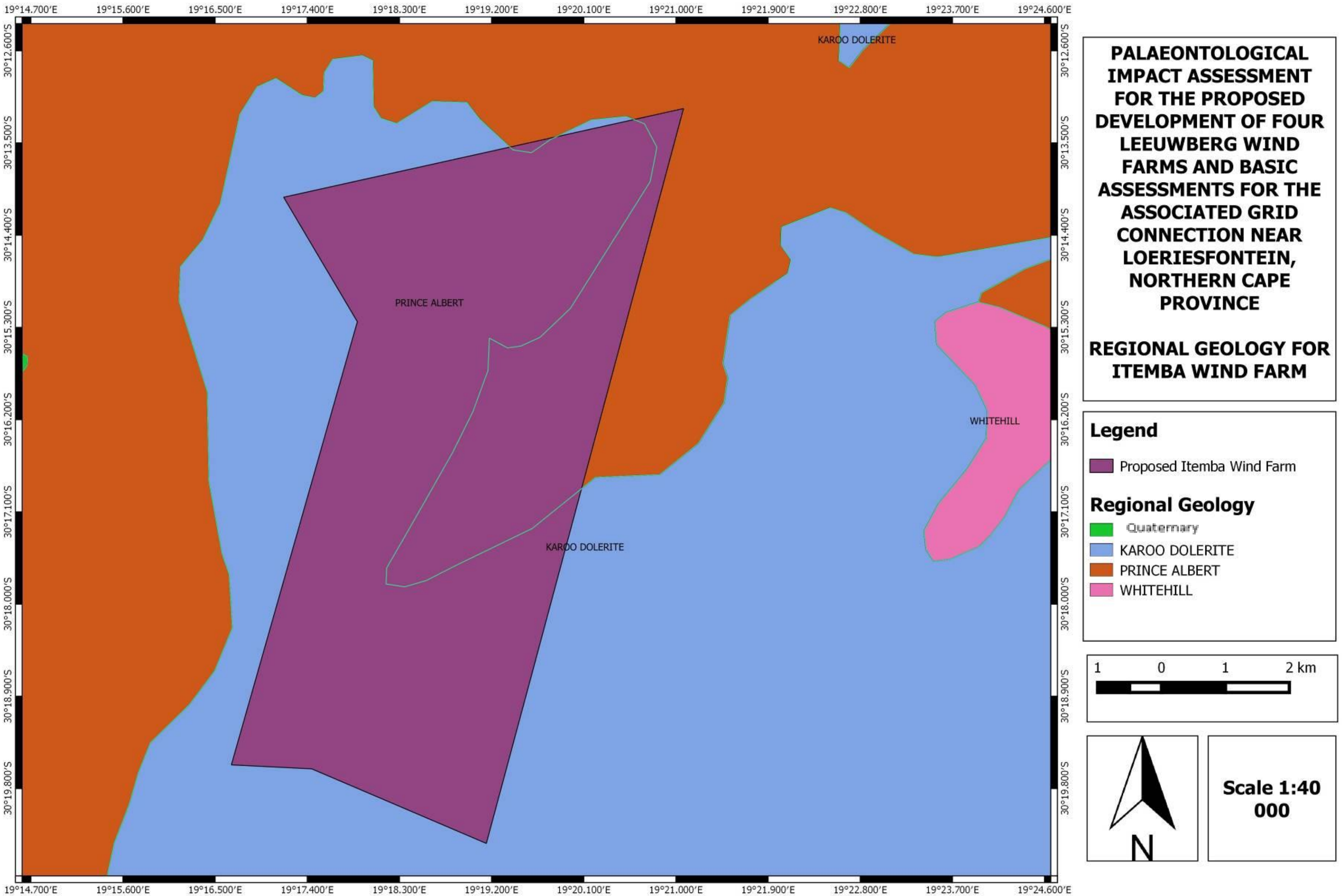

Figure 7. The surface geology of the proposed Itemba Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert and Whitehill Formations of the Ecca Group. Map drawn by QGIS.

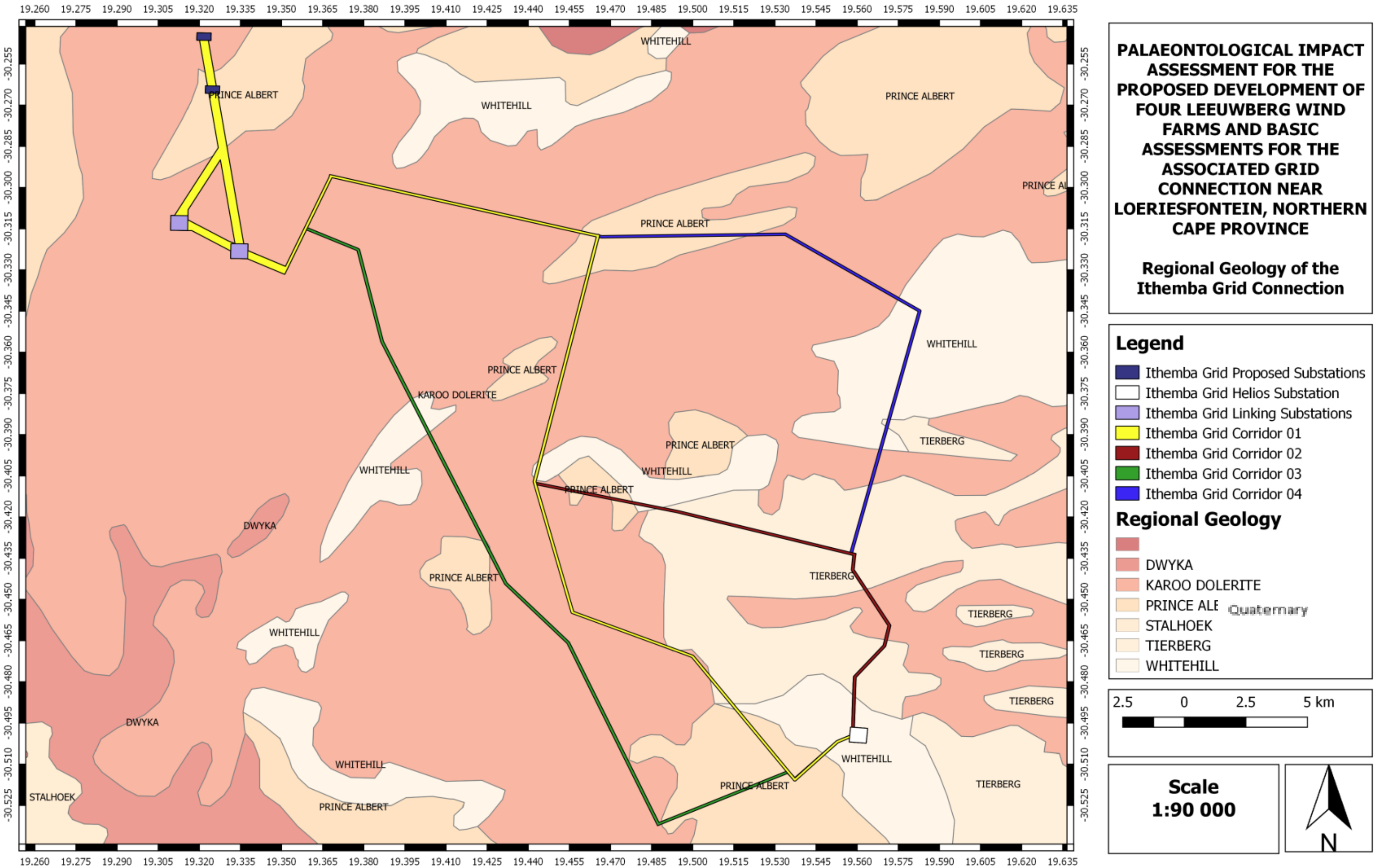

Figure 8. The surface geology of the proposed grid connection of the Itemba Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert, Whitehill and Tierberg Formations of the Ecca Group. Map drawn by QGIS.

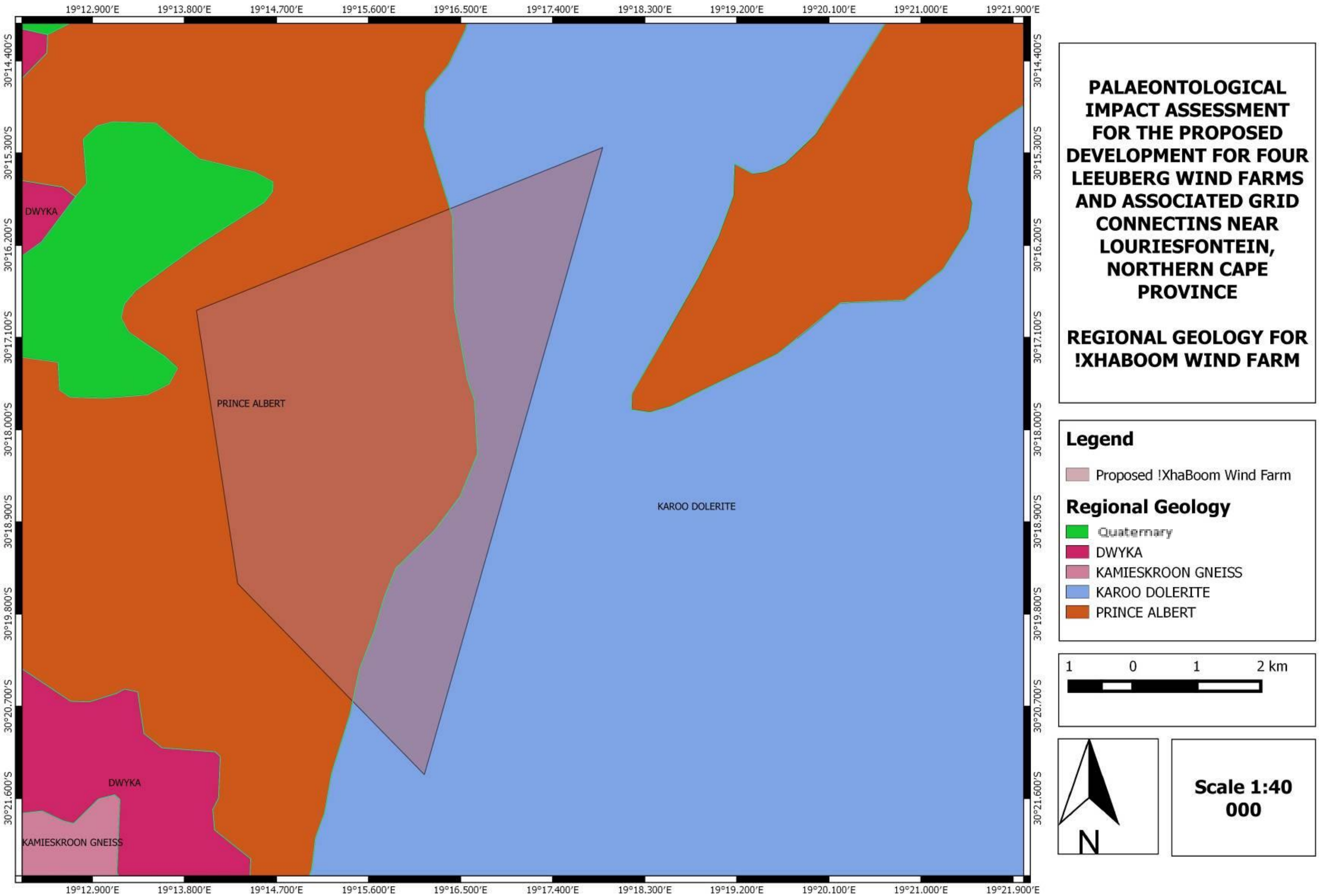

Figure 9. The surface geology of the proposed !XhaBoom Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert Formation of the Ecca Group. Map drawn by QGIS.

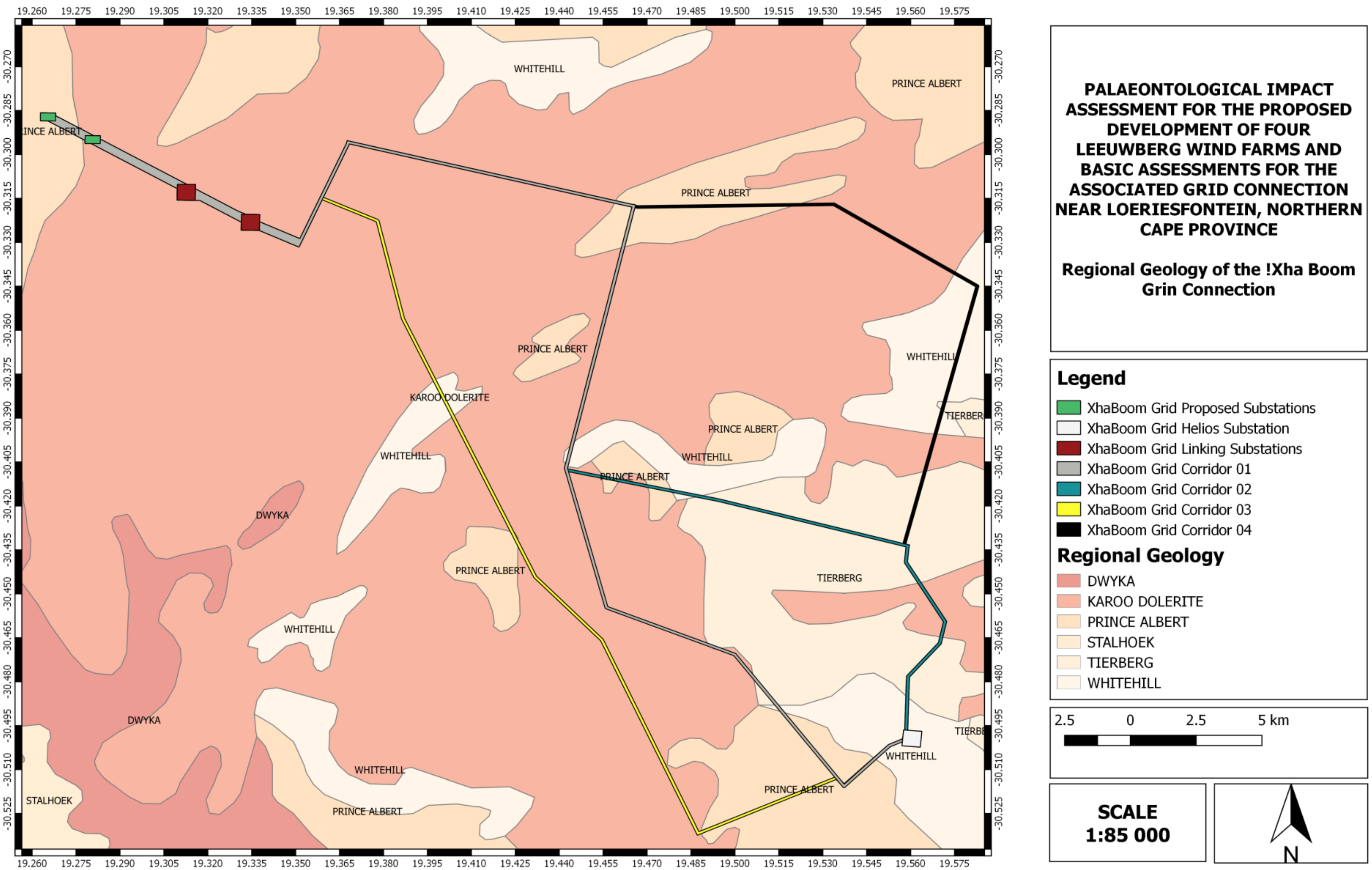

Figure 10. The surface geology of the proposed grid connection of the !XhaBoom Wind Farm near Loeriesfontein in the Northern Cape Province. The development footprint is underlain by Karoo Dolerite as well as the Prince Albert Formation of the Ecca Group. Map drawn by QGIS.

9 GEOGRAPHICAL LOCATION OF THE SITE

9.1 Project Location

The Leeuwberg Wind Farm project area will be located approximately 62km north of Loeriesfontein, in the Khai-ma and Hantam Local Municipalities within the Northern Cape Province (Fig.1).

10 METHODS

A Palaeontological Scoping study was conducted on a desktop level to assess the potential risk to palaeontological material (fossil and trace fossils) within the site proposed for development. The author's experience, aerial photos (using Google Earth, 2015), topographical and geological maps and other reports from the same area were used to assess the site proposed for the development.

11 ASSUMPTIONS AND LIMITATIONS

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

The entire South Africa have not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area. Thus, the accuracy of the Palaeontological Impact Assessment is improved by a field-survey.

12 FINDINGS AND RECOMMENDATIONS

The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian rocks of the lower part of the Ecca Group (Karoo Supergroup). This include the Prince Albert, Whitehill and Tierberg Formations. Permian and Jurassic bedrocks are covered with a range of superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age. .

The Permo-Carboniferous Dwyka Group is known for its track ways that was mostly formed by fish and arthropods (invertebrates) as well as fossilized faeces (coprolites). Fossils other than trace assemblages are generally uncommon and most of the Dwyka sediments are of low overall palaeontological sensitivity. When body fossils do occur it is of marine fish, gastropods and invertebrates as well as fossil plants, spores and pollens.

The fossil assemblage of the **Prince Albert Formation** consists basically of trace fossils, whereas plant fossils are found in large quantities in the sandstone rich sections in the northern parts of the Basin. The trace fossil assemblage of the non-marine *Mermia* Ichnofacies, is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails) and are normally found in basinal mudrock facies of the Prince Albert Formation.

Fossil Heritage of the **Whitehill Formation** includes mesosaurid reptiles, palaeoniscoid fish, small eocarid crustaceans, insects, and trace fossils of king crab as well as possible shark coprolites, palynomorphs, petrified wood (mainly of primitive gymnosperms, silicified or calcified) and rare vascular plant remains.

The fossil assemblage of the **Tierberg Formation** comprise of disarticulated micro vertebrate remains (e.g. fish teeth, scales) sponge remains, rare vascular plants (leaves and petrified wood) with a medium diversity of trace fossil assemblages.

The Karoo Dolerite Suite consists of igneous rocks and are unfossiliferous. Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil biotas. Fossils assemblages may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells and freshwater stromatolites are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

According to the SAHRIS PlaeoMap the Dwyka Group has a low Palaeontological Sensitivity while the Ecca Group (Tierberg and Whitehill Fromations) has a moderate palaeontological Sensitivity. But, the

Palaeontological Sensitivity of the Prince Albert Formation is High and thus a site visit is recommended.

Prior to construction a detailed palaeontology study will thus be conducted to assess the value and importance of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the detailed Report is to elaborate on the issues and potential impacts identified during the initial study undertaken for the Basic Assessment (BA). This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the BA. The report will be submitted to SAHRA before the commencement of any development-related activities.

13 IMPACT TABLE

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
Destruction of Fossil Heritage		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		

This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		

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

SIGNIFICANCE

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

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

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

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.

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

Table 1. Impact Assessment.

IMPACT TABLE	
Environmental Parameter	*Impact on the Palaeontology Heritage (fossils) of the development footprint*
Issue/Impact/Environmental Effect/Nature (E)	The excavations and vegetation clearance during the construction phase will involve extensive excavations into the superficial deposits as well as locally into the underlying bedrock. These excavations will transform the present topography and may disrupt and destroy or permanently lock-in fossils at or beneath the ground surface that are no longer accessible for research. This impact will usually only occur during the construction phase. No impacts are expected to occur during the operation phase.
Extent	The Leeuwberg Wind Farm project area will be located approximately 62km north of Loeriesfontein, in the Khai-ma and Hantam Local Municipalities within the Northern Cape Province. *A brief description of the area over which the impact will be expressed*
Probability	The development footprint is underlain by the Permo-Carboniferous Dwyka Group and Early to Middle Permian basinal mudrocks of the lower part of the Ecca Group (Karoo Supergroup). Permian and Jurassic bedrocks are covered with various superficial deposits, mostly Late Caenozoic (Quaternary to Recent) in age. The intrusive Karoo dolerites are of no palaeontological significance and the Late Caenozoic superficial deposits are generally of very low palaeontological sensitivity. The Dwyka Group is known for fish, microfossils, marine invertebrates, trace fossils and vascular plants. Aquatic vertebrate fossils (fish and mesosaurid reptiles), invertebrates and petrified wood has been identified from the Whitehill Formation. These

	fossils are infrequent in the Prince Albert and Tierberg Formations. According to the SAHRIS PlaeoMap the **Dwyka Group** has a **low Palaeontological Sensitivity** while the **Ecca Group** (Tierberg and Whitehill Fromations) has a **moderate palaeontological Sensitivity**. **But, the Palaeontological Sensitivity of the Prins Albert Formation is High.** The probability of significant impacts on palaeontological heritage during the construction phase is low.
Reversibility	Impacts on fossil heritage are commonly irreversible. And thus well-documented records and additional palaeontological studies of fossils exposed through construction would characterise a positive impact scientifically. The probability of a negative impact on the palaeontological heritage of the area can be reduced by the execution of suitable damage mitigation procedures. If damage mitigation is correctly undertaken the benefit scale for the project will lie within the beneficial category. *Fossil Heritage is expected in the Prince Albert Formation while the Ecca group has a moderate probability and the Dwyka Group a low probability of finding fossils*
Irreplaceable loss of resources	The development footprint is underlain by the Dwyka Group (low Palaeontological Sensitivity) and Ecca Group of the Karoo Supergroup. This include the Prince Albert (high Palaeontological Sensitivity), Whitehill and Tierberg with a moderate Palaeontological Sensitivity. Permian and Jurassic bedrocks are covered with a range of superficial deposits generally of low palaeontological sensitivity. The intrusive Karoo dolerites are of no palaeontological significance
Duration	The expected duration of the impact is assessed as potentially permanent to **long term**. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be **permanent**
Cumulative effect	Low Cumulative Impact The cumulative effect of the development area within the proposed location is considered to be **moderate.** The broader area near Loeriesfontein is underlain by the Dwyka Group (low Palaeontological Sensitivity) and Ecca Group of the Karoo Supergroup. This include the Prince Albert (high Palaeontological

	Sensitivity), Whitehill and Tierberg with a moderate Palaeontological Sensitivity. Permian and Jurassic bedrocks are covered with a range of superficial deposits generally of low palaeontological sensitivity. The intrusive Karoo dolerites are of no palaeontological significance	
Intensity/magnitude	Probable significant impacts on palaeontological heritage during the construction phase are high (Prince Albert Formation), and the intensity of the impact on fossil heritage is rated as high	
Significance Rating	*A brief description of the importance of an impact which in turn dictates the level of mitigation required*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	1
Reversibility	1	1
Irreplaceable loss	3	1
Duration	4	1
Cumulative effect	4	1
Intensity/magnitude	3	1
Significance rating	-48 (negative medium)	-6 (negative low)
Mitigation measures	Suggested mitigation of the predictable damage and destruction of fossil within the proposed development area would involve the description and collecting of fossils within the development footprint by a professional palaeontologist. This work should take place after initial vegetation clearance but *prior to* ground levelling for construction Impacts on fossil heritage are usually irreversible. And thus well-documented records and additional palaeontological studies of fossils exposed through construction would characterise a positive impact scientifically. The probability of a negative impact on the palaeontological heritage of the area can be reduced by the execution of suitable damage mitigation procedures. If damage mitigation is correctly undertaken the benefit scale for the project will lie within the beneficial category. A site visit to the Prince Albert Formation would provide information on the presence of fossil Heritage	

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

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