PALAEONTOLOGICAL DESKTOP ASSESSMENT

SYCHROPLEX MINING RIGHT COMBINED WITH A WASTE LICENCE APPLICATION NEAR UPINGTON IN THE NORTHERN CAPE PROVINCE

REF: NC30/5/1/2/2/10218MR

February 2023

COMPILED FOR: MILNEX CC

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations, and all other applicable legislation.
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority.
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application.
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct.
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal, or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE: 

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

Table 1: NEMA Table	
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A
(ii) The expertise of that person to compile a specialist report including a curriculum vitae	Section 2 – refer to **Appendix A**
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Objective
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Desktop Assessment
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 1 and 10
(g) An identification of any areas to be avoided, including buffers	Section 5 No buffers or areas of sensitivity identified
(h) A map superimposing the activity including the associated structures and infrastructure on the	Section 5 – Geological and Palaeontological history

Table 1: NEMA Table	
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**
environmental sensitivities of the site including areas to be avoided, including buffers;	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – Assumptions and Limitation
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 1 and 10
(k) Any mitigation measures for inclusion in the EMPr	Section 11
(l) Any conditions for inclusion in the environmental authorisation	Section 11
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 10
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 10
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and	
(n)(ii) If the opinion is that the proposed activity, activities, or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 1 and 10
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A
(p) A summary and copies if any comments that were received during any consultation process	N/A
(q) Any other information requested by the competent authority.	N/A
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Milnex CC to conduct the Palaeontological Desktop Assessment (PDA) to assess the proposed Mining Right combined with a Waste Licence Application to mine for Copper, Zinc, Sulfur, Iron and associated minerals within the orebody, on Portion 2 & the Remaining Extent of the Farm Areachap 426, Registration Division Gordonia, near Upington in the Northern Cape Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PDA is necessary to verify if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The development footprint is underlain by the Superficial sediments of the Gordonia Formation (Kalahari Group) as well as the Dwyka Group of the Karoo Supergroup. However, the minerals will be mined from deep below the earth's surface. At depth the study site is underlain by ancient Precambrian basement rocks that belongs to the Namaqua-Natal Province of Mid Proterozoic (Mokolian) age and comprises of largely high-grade metamorphic rocks (*e.g.* metapelites, gneisses) and intrusive granitoids. These rocks are about two to one billion years old and are entirely unfossiliferous. Updated geology corresponds with that of the 1998 Geological. The PalaeoMap of the South African Heritage Resources Information System indicates that the Palaeontological Sensitivity of the Dwyka Group is moderate. A low Palaeontological Significance has thus been allocated to the proposed development. It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. It is considered that the development of the proposed development will not lead to detrimental impacts on the palaeontological resources of the area.

If fossil remains are discovered during any phase of construction, either on the surface or below, the ECO in charge of these developments must be alerted immediately. These discoveries should be protected (if possible, *in situ*) and the ECO must report to SAHRA so that appropriate mitigation can be carry out by a professional paleontologist. SAHRA Contact details: South African Heritage Resources Agency, 111 Harrington Street, PO Box 4637, Cape Town 8000, South Africa. Email: Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509 Web: www.sahra.org.za)

Preceding any collection of fossil material, the specialist would need to apply for collection permit from SAHRA. Fossil material must be housed in an approved collection (museum or university) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

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Appendix A:

Curriculum Vitae Elize Butler

1 INTRODUCTION

Milnex CC was contracted by Sychroplex (Pty) Ltd as the independent environmental consultant to undertake the Scoping and EIA process for a Mining Right combined with a Waste Licence Application to mine for Copper, Zinc, Sulfur, Iron and associated minerals within the orebody, on Portion 2 & the Remaining Extent of the Farm Areachap 426, Registration Division Gordonia, near Upington in the Northern Cape Province. Banzai Environment was in turn appointed to conduct the Palaeontological Desktop Assessment for this project (Figure 1-2).

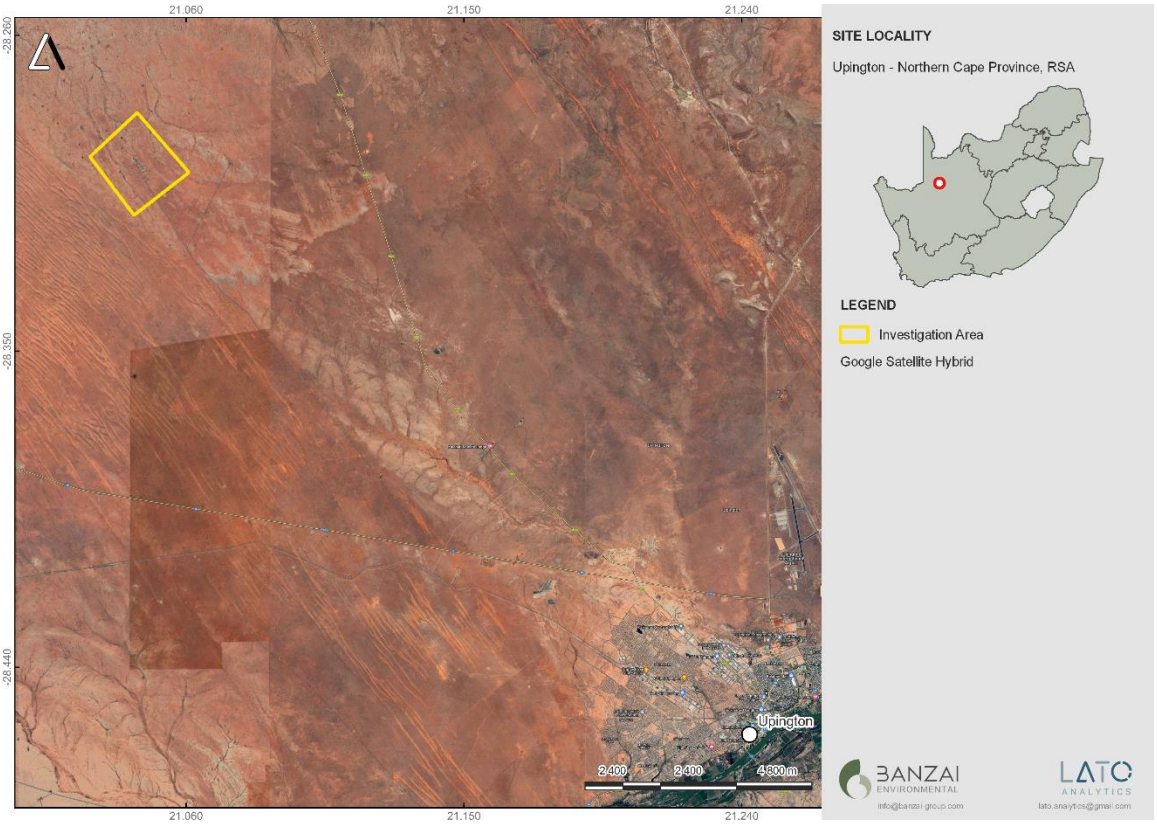


***Figure 1**: Google Earth (2022) image indication the regional locality of the proposed Sychroplex Mining Right development.*

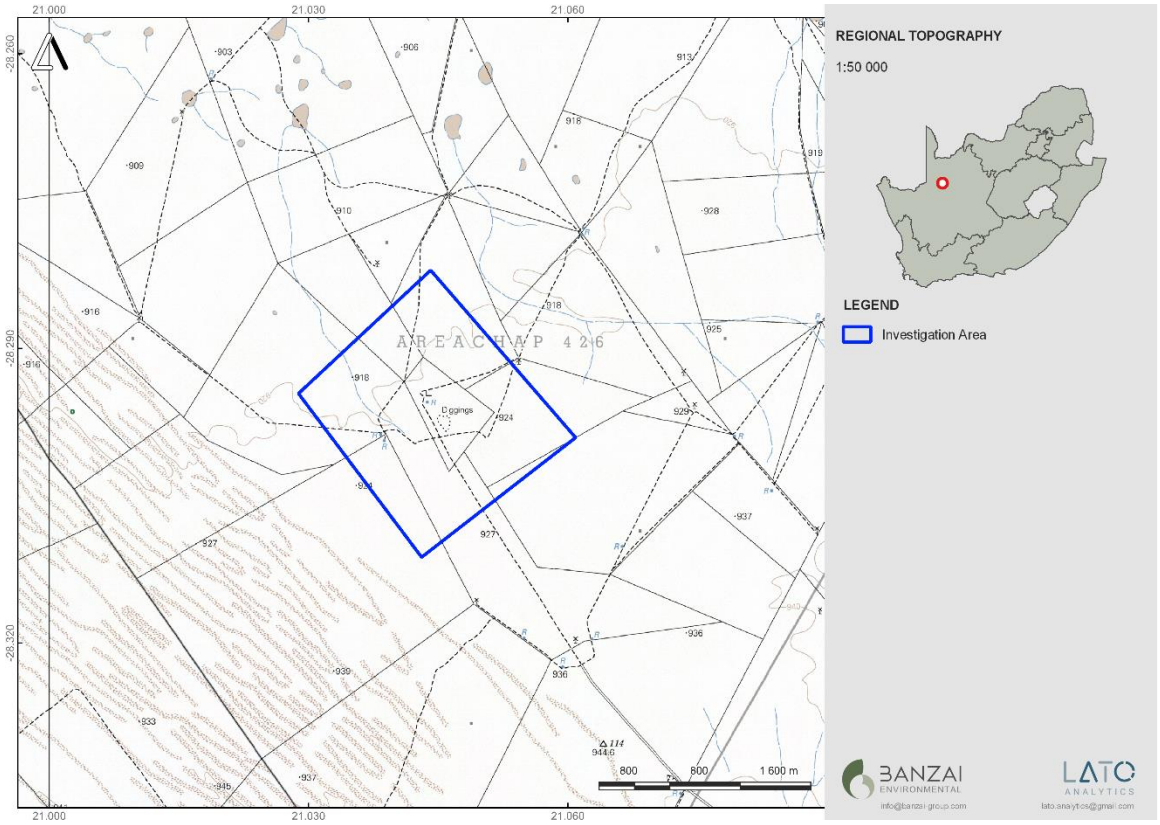


Figure 2: *Locality Map of the proposed Sychroplex Mining Right development*

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

3 LEGISLATION MANDATE

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"**all

objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

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

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

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

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

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

National Heritage Resources Act (NHRA) Act 25 of 1999

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

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50
- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

The NEMA (No 107 of 1998) states that an integrated EMP should (23:2 (b)) "*…identify, predict, and evaluate the actual and potential impact on the environment, socio-economic conditions, and cultural heritage*".

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

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

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

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

4 OBJECTIVE

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

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

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

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

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

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Adherence to all applicable best practice recommendations, appropriate legislation, and authority requirements.
- Submit a comprehensive overview of all appropriate legislation, guidelines.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kml's) in the proposed development.
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect, and cumulative:
    a. Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity.

c. Cumulative impacts result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present, or reasonably foreseeable future activities.

- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed Sychroplex Mining Right Application combined with a Waste Licence Application is depicted on the 1:250 000 Upington 2822 (1998) Geological map (Council of Geoscience, Pretoria) (Figure 3, Table 2). This map indicates that the proposed development is underlain by the Gordonia Formation (Qg; Kalahari Group) as well as the Dwyka Group (C-Pd, blue-grey, Karoo Supergroup). At depth the study site is underlain by ancient Precambrian basement rocks that belongs to the Namaqua-Natal Province of Mid Proterozoic (Mokolian) age (Cornell *et al.* 2006, Moen 2007) and comprises of largely high-grade metamorphic rocks (*e.g.* metapelites, gneisses) and intrusive granitoids. These rocks are about two to one billion years old and are unfossiliferous (Almond and Pether, 2008). Updated geology corresponds with that of the 1998 Geological map (Figure 4) According to the South African Heritage Resources Information System, the Palaeontological Sensitivity of the Gordonia Formation (Kalahari Group) and that of the Dwyka Group is Moderate (Figure 5). The Palaeontological Sensitivity of the Precambrian basement rocks (Namaqua-Natal Province) is zero.

The late Cretaceous to Recent Kalahari Group has been reviewed by the following authors: Thomas (1981), Dingle *et al.* (1983), Thomas & Shaw 1991, Haddon (2000) and Partridge *et al.* 2006. The Quaternary Gordonia Formation (Kalahari Group) are dated as Late Pliocene/Early Pleistocene to Recent times by the Middle to Later Stone Age stone tools recovered from them (Dingle et al (1983). The fossil assemblages of the Quaternary are generally Low in diversity and occur over a wide range and mostly has a Moderate Paleontologically Sensitivity. These fossils represent terrestrial plants and animals with a close resemblance to living forms. Fossil assemblages include bivalves, diatoms, gastropod shells, ostracods, and trace fossils. The palaeontology of the Quaternary superficial deposits has been relatively neglected in the past. Late Cenozoic calcrete may comprise of bones, horn corns as well as mammalian teeth. Tortoise remains have also been uncovered as well as trace fossils which includes termite and insect's burrows and mammalian trackways. Amphibian and crocodile skeletons have been uncovered where the depositional settings in the past were wetter.

During the climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa where formed (Maud, 2012). Barnosky (2005) indicated that various warming and cooling events occurred in the Cenozoic but states that climatic changes during the Quaternary Period, specifically the last 1.8 Ma, were the most drastic climate changes relative to all climate variations in the past. Climate

variations that occurred in the Quaternary Period were both drier and wetter than the present and resulted in changes in river flow patterns, sedimentation processes and vegetation variation (Tooth et al., 2004).

The Dwyka Group is Late Carboniferous to Early Permian in age (300-290 Million years ago (Ma)) and overlies glaciated Precambrian bedrock faces along the northern margin of the basin. In the south the Dwyka overlies the Cape Supergroup unconforrmably/paraconformably and in the east it unconformably overlies the Natal Group and Msikaba Formation. Underlying rocks, especially in the north, form in places well-developed striated glacial pavements. Visser (1986) identified several types of lithofacies which he perceived to be deposited in a marine basin.

The Dwyka Group is divided into northern and southern facies (Visser, 1981) due to the distinctive lithological variations over the basin. The Mbizane Formation consists mainly of the northern inlet facies which is characterised by thickness changes, extremely varying lithology and low massive diamictite (~20 %) and high mudrock (~40%) content. The Elandsvlei Formation is the southern platform and are depicted by a high massive diamictite (~70%) and low mudrock (~8%) content, gradual southernly increase in thickness (100 m to 800 m). Debris eroded, from the highlands was deposited by a ground ice sheet but in the west fluctuations in the ice front caused bedded diamictons and subaqueous and subglacial outwash sediments (Visser *et al* 1987). The key Reference Stratotype C section for the Mbizane Formation is situated a few km west of Douglas on the northern side of the Vaal River (Von Brunn & Visser, 1999)

The Dwyka sediments are of moderate palaeontological sensitivity. The Permo-Carboniferous Dwyka Group is known for its track-ways (trace fossils), which are also known as ichnofacies, that were formed by fish and arthropods, while fossilized faeces (coprolites) have also been recovered. Body fossils comprise of gastropods, invertebrates, and marine fish. Fossil plants include a rich diversity of conifers, cordaitaleans, glossopterids, ginkgoaleans, horsetails, lycopods, pollens and fern spores (Almond and Pether, 2008). Records indicate that the fossils recorded from the Dwyka Group in the region are ice-transported boulders of Precambrian limestone or dolomite that comprise of small stromatolites (microbial mounds/columns).

The Namaqua-Natal Province basement rocks consists of tectono-stratigraphic terranes assembled during the Namaqua Orogeny. The three main lithostratigraphic components (Cornell et al, 2006) include

- reworked Kheisian rocks (late Palaeoproterozoic) that are about 2000 Ma old,
- juvenile supracrustal and plutonic rocks formed about 1600 to 1200 Ma and assembled during collision events that were accompanied by metamorphism and deformation
- between 1200 and 1000 Ma voluminous syn- and post-tectonic granitoids formed.

The Areachap Terrane comprise of 1000 Ma granitoids (Keimoes Suite) as well as a juvenile NNW-trending belt of about 1300 Ma arc-related supracrustal rocks. The latter comprise of amphibolite-grade metabasic and intermediate supracrustal gneisses of the Areachap Group.

These basement rocks only crop out in small isolated patches to the east of the development (Figure 3) but underlies the younger sediments (Dwyka and Kalahari Groups).

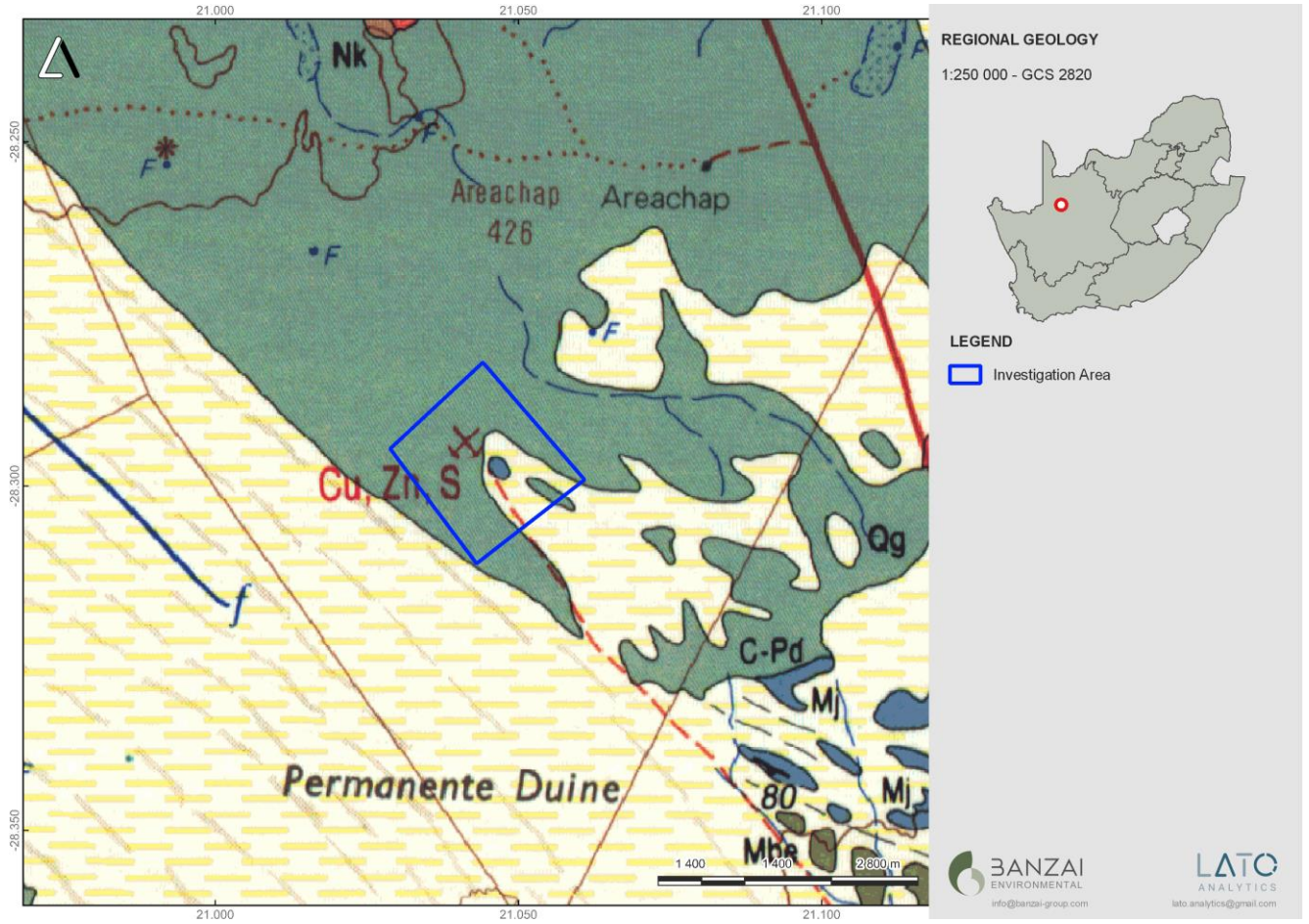
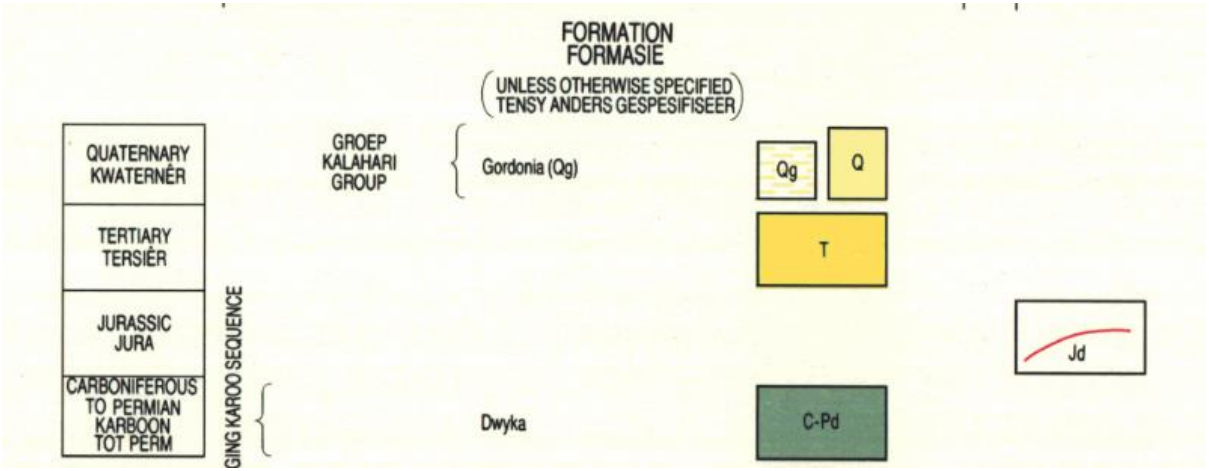
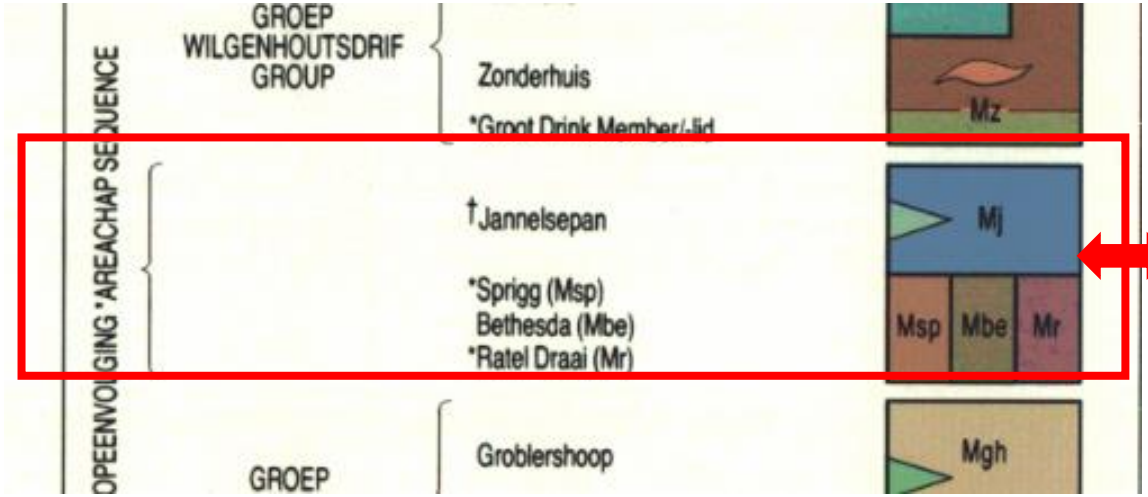
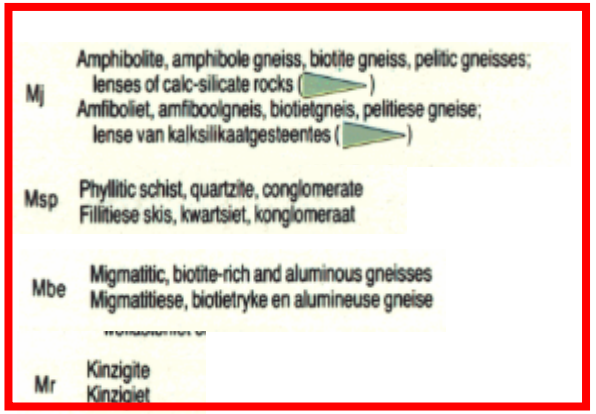


Figure 3: Extract of the 1:250 000 Upington 2822 (1998) Geological map (Council of Geoscience, Pretoria) indicating the proposed development in blue. The proposed development is underlain by the Gordonia Formation of the Kalahari Group, the Dwyka Group (C-Pd, blue-grey, Karoo Supergroup) underlain at depth by ancient Precambrian basement rocks.

***Table 2**: Legend of the 1:250 000 Upington 2820 Geological map (1998) Geological map (Council of Geoscience, Pretoria).*







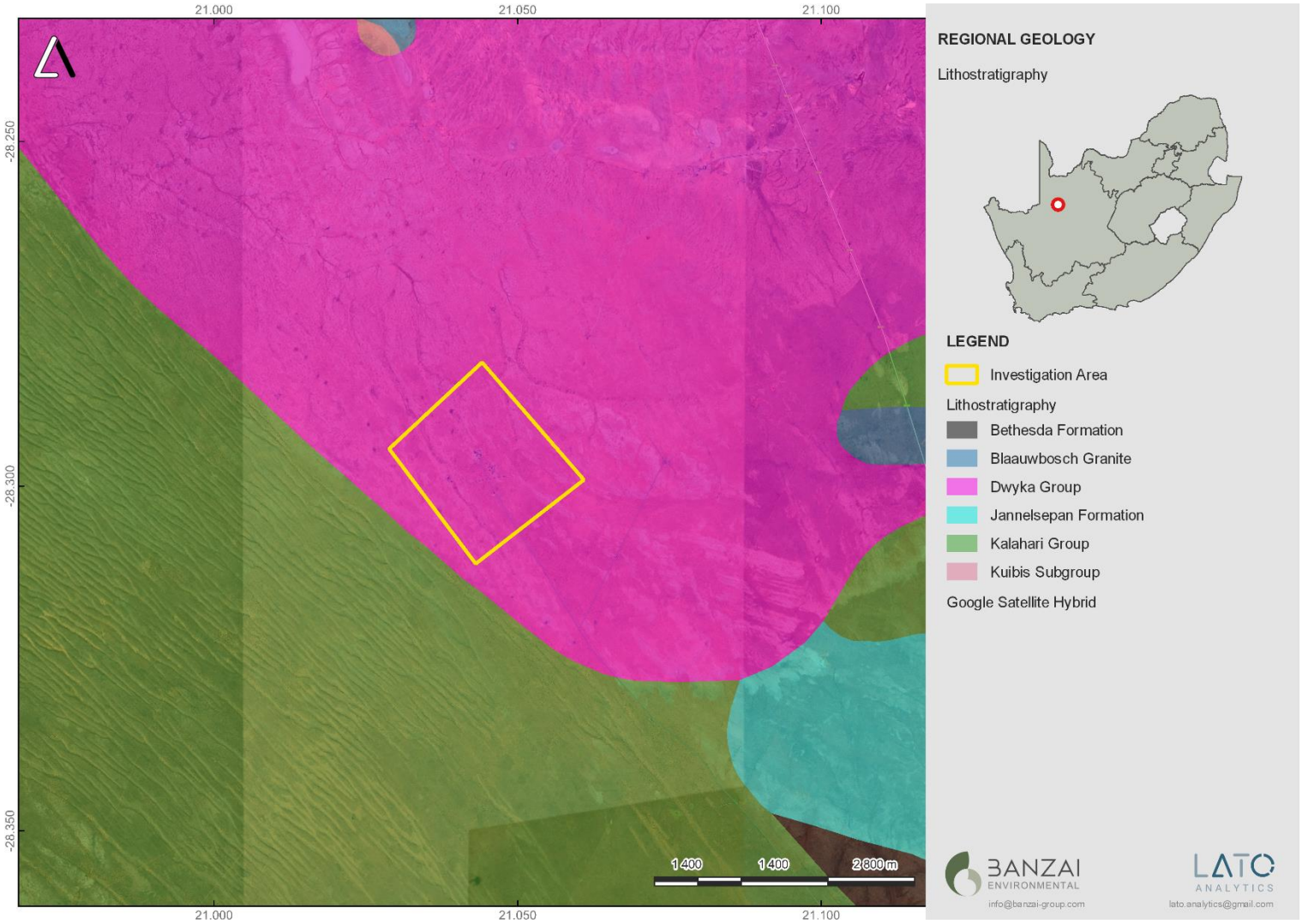


***Figure 4**: Updated geology (Council for Geosciences, Pretoria) of the proposed development indicates that the development is underlain by the Dwyka Group (Karoo Supergroup).*

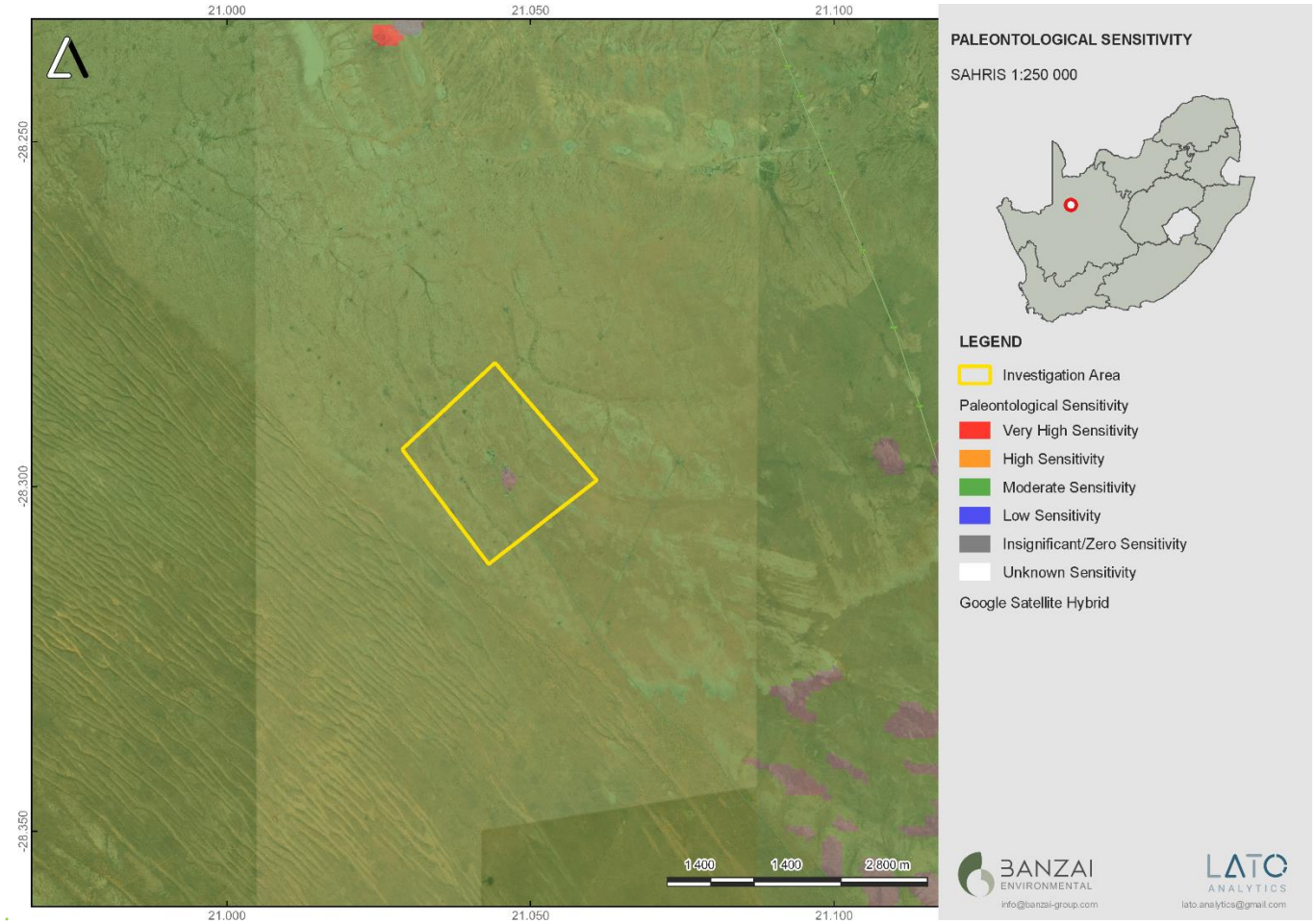


Figure 5: *Extract of the 1 in 250 000 SAHRIS PalaeoMap (Council of Geosciences) indicating the Palaeontological Sensitivity of the proposed development.*

According to the SAHRIS Palaeosensitivity map (**Figure 5**) the proposed development is underlain by sediments with a Moderate (green), Palaeontological Sensitivity.

***Table 3**: SAHRIS Palaeosensitivity ratings table.*
The relevant sensitivities are highlighted

Colour	Sensitivity	Required Action
RED	VERY HIGH	Field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study; a field assessment is likely
GREEN	**MODERATE**	**Desktop study is required**
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	No palaeontological studies are required
WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

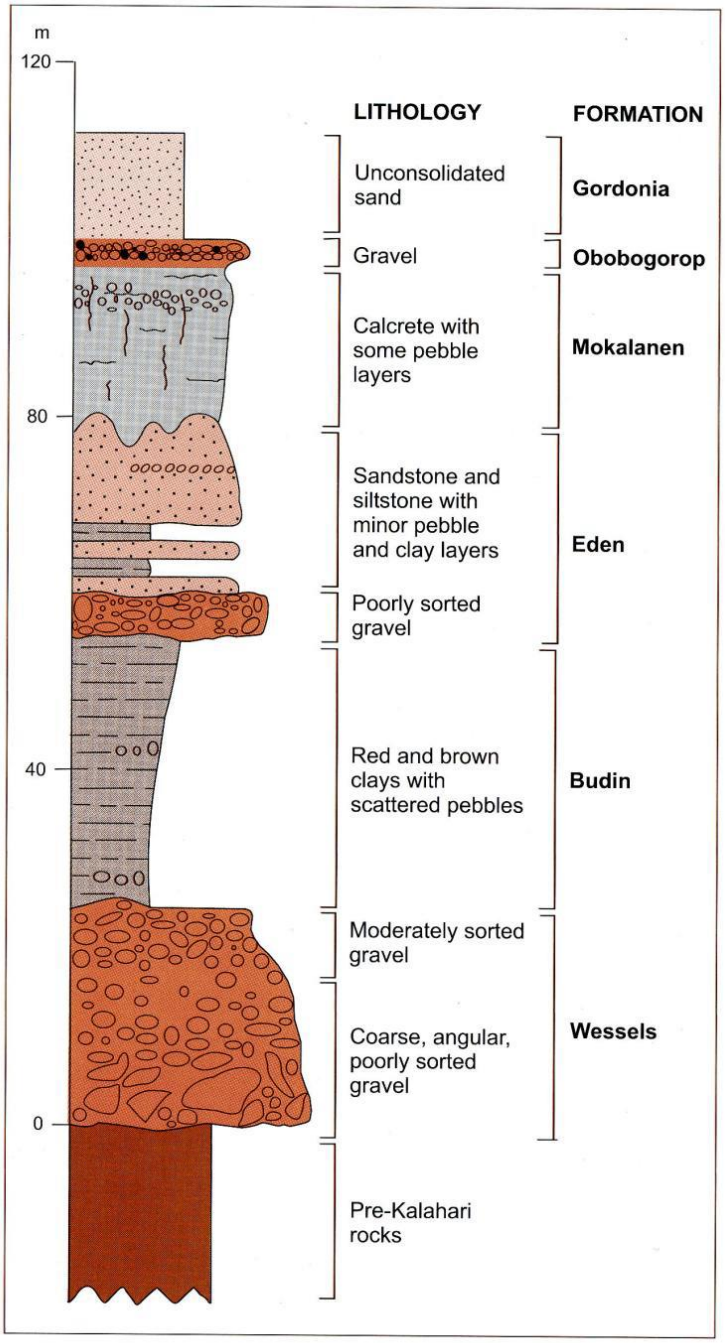


***Figure 6**: Stratigraphy of the Kalahari Group (Image taken from Partridge et al., 2006). Calcretes and aeolian sands of the Gordonia Formation possibly corresponds to the Mokalanen Formation.*

6 GEOGRAPHICAL LOCATION OF THE SITE

The property is situated about 25km north west of Upington in the Northern Cape Province (Figure 1-2)

The following information was obtained from Milnex CC

***Table 4**:Project information*

Farm Name	FARM NAME	MAGISTERIAL DISTRICT	REGISTRATION DIVISION
	1) Remaining Extent of the Farm Areachap 426	ZF Mgcawu District Municipality	Gordonia
	2) Portion 2 of the Farm Areachap 426		
Application area (Ha)	512 Hectares		
Depth of the mineral below surface	From Surface extending to ~900m below surface.		
Distance and direction from nearest town	Situated 25 Km north west from the town of Upington in the Northern Cape Province		
21-digit Surveyor General Code for each farm portion	1. C02800000000042600000 2. C02800000000042600002		
Minerals Applied for	1. Copper 2. Zinc 3. Sulfur 4. Iron and Associated minerals within the orebody		

Table 5:GPS coordinates

Farms	Latitude	Longitude
Remaining Extent of the Farm Areachap 426 Portion 2 of the Farm Areachap 426	21.04412	28.28205
	21.06089	28.29909
	21.04308	28.31126
	21.02834	28.28206

7 METHODS

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

7.1 Assumptions and Limitations

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

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

8 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984).
- A Google Earth map with polygons of the proposed development was obtained from Milnex cc.
- 1:250 000 Upington 2820 Geological map (1998) (Council of Geoscience, Pretoria)
- Updated Geology (Council of Geosciences, Pretoria).

9 IMPACT ASSESSMENT METHODOLOGY

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

- Construction.
- Operation; and
- Decommissioning.

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

***Table 6**: The rating system*

NATURE		
The Nature of the Impact is the possible destruction of fossil heritage		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).

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

3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible, and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		

This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity = X. 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

9.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a Low probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

***Table 7**: Summary of Impact Tables*

	Site	Probability	Duration	Magnitude	Reversibility	Irreplicable Loss	Cumulative Effect	Significance
	1	2	4	1	4	4	2	17

10 FINDINGS AND RECOMMENDATIONS

The development footprint is underlain by the Superficial sediments of the Gordonia Formation (Kalahari Group) as well as the Dwyka Group of the Karoo Supergroup. However, the minerals will be mined from deep below the earth's surface. At depth the study site is underlain by ancient Precambrian basement rocks that belongs to the Namaqua-Natal Province of Mid Proterozoic (Mokolian) age and comprises of largely high-grade metamorphic rocks (*e.g.* metapelites, gneisses) and intrusive granitoids. These rocks are about two to one billion years old and are entirely unfossiliferous. Updated geology corresponds with that of the 1998 Geological. The PalaeoMap of the South African Heritage Resources Information System indicates that the Palaeontological Sensitivity of the Dwyka Group is moderate. A low Palaeontological Significance has thus been allocated to the proposed development. It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils. It is considered that the development of the proposed development will not lead to detrimental impacts on the palaeontological resources of the area.

If fossil remains are discovered during any phase of construction, either on the surface or below, the ECO in charge of these developments must be alerted immediately. These discoveries should be protected (if possible, *in situ*) and the ECO must report to SAHRA so that appropriate mitigation can be carry out by a professional paleontologist. SAHRA Contact details: South African Heritage Resources Agency, 111 Harrington Street, PO Box 4637, Cape Town 8000, South Africa. Email: Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509 Web: www.sahra.org.za)

Preceding any collection of fossil material, the specialist would need to apply for collection permit from SAHRA. Fossil material must be housed in an approved collection (museum or university) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

11 CHANCE FIND PROTOCOL

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

11.1 LEGISLATION

Cultural Heritage in South Africa (includes all heritage resources) is protected by the National Heritage Resources Act (Act No 25 of 1999) (NHRA). According to Section 3 of the Act, all Heritage resources include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

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

A fossil is the naturally preserved remains (or traces thereof) of plants or animals embedded in rock. These organisms lived millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine environmental conditions that existed in a specific geographical area, millions of years ago.

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when construction activities accidentally uncover fossil material.

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

11.2 CHANCE FIND PROCEDURE

- If a chance find is made the person responsible for the find must immediately stop working and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately report the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape

Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za).

The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within 24 hours of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. No attempt should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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APPENDIX 1:

CURRICULUM VITAE

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	30 years in Palaeontology
EDUCATION:	B.Sc Botany and Zoology, 1988 University of the Orange Free State
	B. Sc (Hons) Zoology, 1991 University of the Orange Free State
	Management Course, 1991 University of the Orange Free State
	M. Sc. *Cum laude* (Zoology), 2009 University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997

Principal Research Assistant	National Museum, Bloemfontein
and Collection Manager	1998–2022

TECHNICAL REPORTS

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Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.
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Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State. Bloemfontein.
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Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. Bloemfontein.
Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.
Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.
Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.
Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.
Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.
Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commissioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.
Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.
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Butler, E. 2018 Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.
Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province. Bloemfontein.
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Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of a new 11kV (1.3km) Power Line to supply electricity to a cell tower on farm 215 near Delportshoop in the Northern Cape. Bloemfontein.
Butler, E. 2018. Palaeontological Field Assessment of the proposed construction of a new 22 kV single wood pole structure power line to the proposed MTN tower, near Britstown, Northern Cape Province. Bloemfontein.
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Butler, E. 2018. Proposed Kalabasfontein Mine Extension project, near Bethal, Govan Mbeki District Municipality, Mpumalanga. Bloemfontein.
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Butler, E., 2019. Recommended Exemption from further Palaeontological Studies for Proposed formalisation of Gamakor and Noodkamp low-cost Housing Development, Keimoes, Gordonia Rd, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.
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