



**PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED EXPANSIONS
OF THE EXISTING MOLARE PIGGERY INFRASTRUCTURE AND RELATED ACTIVITIES
ON PORTION 0(RE) OF THE FARM ARENDSFONTEIN 464 JS, PORTION 0(RE) OF THE
FARM WANHOOP 443 JS, PORTION 0(RE) OF THE FARM EIKEBOOM 476 JS AND
PORTIONS 2 & 7 OF THE FARM KLIPBANK 467 JS WITHIN THE JURISDICTION OF THE
STEVE TSHWETE LOCAL MUNICIPALITY, MPUMALANGA PROVINCE**

Compiled for:

Enviroroots
PO Box 1882
Babsfontein 1510

Prepared by
Banzai Environmental
August 2021

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.

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SIGNATURE:

A handwritten signature in black ink, appearing to read 'Elize Butler'.

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

Table 1 - NEMA Table

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	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 Study	
(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 alternatives;	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	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
environmental sensitivities of the site including areas to be avoided, including buffers;	Palaeontological history	
(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 12	
(l) Any conditions for inclusion in the environmental authorisation	Section 12	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 12	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 11	
(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	Not applicable. A public consultation process will be conducted as part of the EIA and EMPr process.
(p) A summary and copies if any comments that were received during any consultation process	N/A	
(q) Any other information requested by the competent authority.	N/A	Not applicable.

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
(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 Enviroroots to conduct the Palaeontological Impact Assessment (PIA) to assess the proposed expansions of the existing Molare Piggery infrastructure and related activities on Portion 0(Re) of the farm Arendsfontein 464 JS, Portion 0(Re) of the farm Wanhoop 443 JS, Portion 0(Re) of the farm Eikeboom 476 JS and Portions 2 & 7 of the farm Klipbank 467 JS within the jurisdiction of the Steve Tshwete Local Municipality, Mpumalanga Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PDA is necessary to confirm if fossil material could potentially be present in the planned development area and to evaluate the impact of the proposed development on the Palaeontological Heritage.

The Molare Piggery expansion is underlain by rocks of the Vryheid Formation (Ecca Group, Karoo Supergroup, 290-266 million years old) as well as the Kwaggasnek Formation of the Rooiberg Group (Transvaal Supergroup 2.06 billion years old). According to the South African Heritage Resources Information System, the Palaeontological Sensitivity of the Vryheid Formation is Very High, while that of the metamorphic Rooiberg Group is Zero as it is unfossiliferous. The Vryheid Formation is known for its rich assemblage of Glossopteris flora which is the source vegetation for this formation, while fish scales, non-marine bivalves and trace fossils are also present in this formation.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 21 August 2021. No visible evidence of fossiliferous outcrops was identified. For this reason, an overall low palaeontological sensitivity is allocated to the development footprint. The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed development is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. 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.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the Environmental Control Officer (ECO) in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

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1 INTRODUCTION

Information provided by Enviroroots

Molare (Pty) Ltd currently operates their existing piggery operations, comprising of both Sow (breeding) and Grower Units on Portion 0(RE) of the Farm Arendsfontein 464 JS, Mpumalanga Province (**Figure 1-2**). The proposed expansions to the existing infrastructure will take place within the current, already disturbed footprint area of the piggery (**Figure 3**). Existing infrastructure will remain as is.

Approximately 75 000 pigs will be housed at the operations at any given time, following the expansion. The facility is securely fenced, and access is strictly controlled. Clean water is supplied from municipal sources to the Piggery. A portion of the Biodegradable Industrial Wastewater generated by the piggery operations will be irrigated onto agricultural land as a soil conditioning measure following a liquids/solids separation process. The remainder is directed to a natural pan north of the operations to sustain the pan's existing beneficial surface water flow wetland ecosystem, which has been established over the years. The proposed expansion will require a Water Use License by means of a Water Use License Application (WULA) in terms of the National Water Act (NWA), 1998 (Act No. 36 of 1998) for water uses listed under Section 21 of the Act. The methodology and procedural requirements as set out in GNR 267 of 24 March 2017, promulgated in terms of the NWA, will be followed.

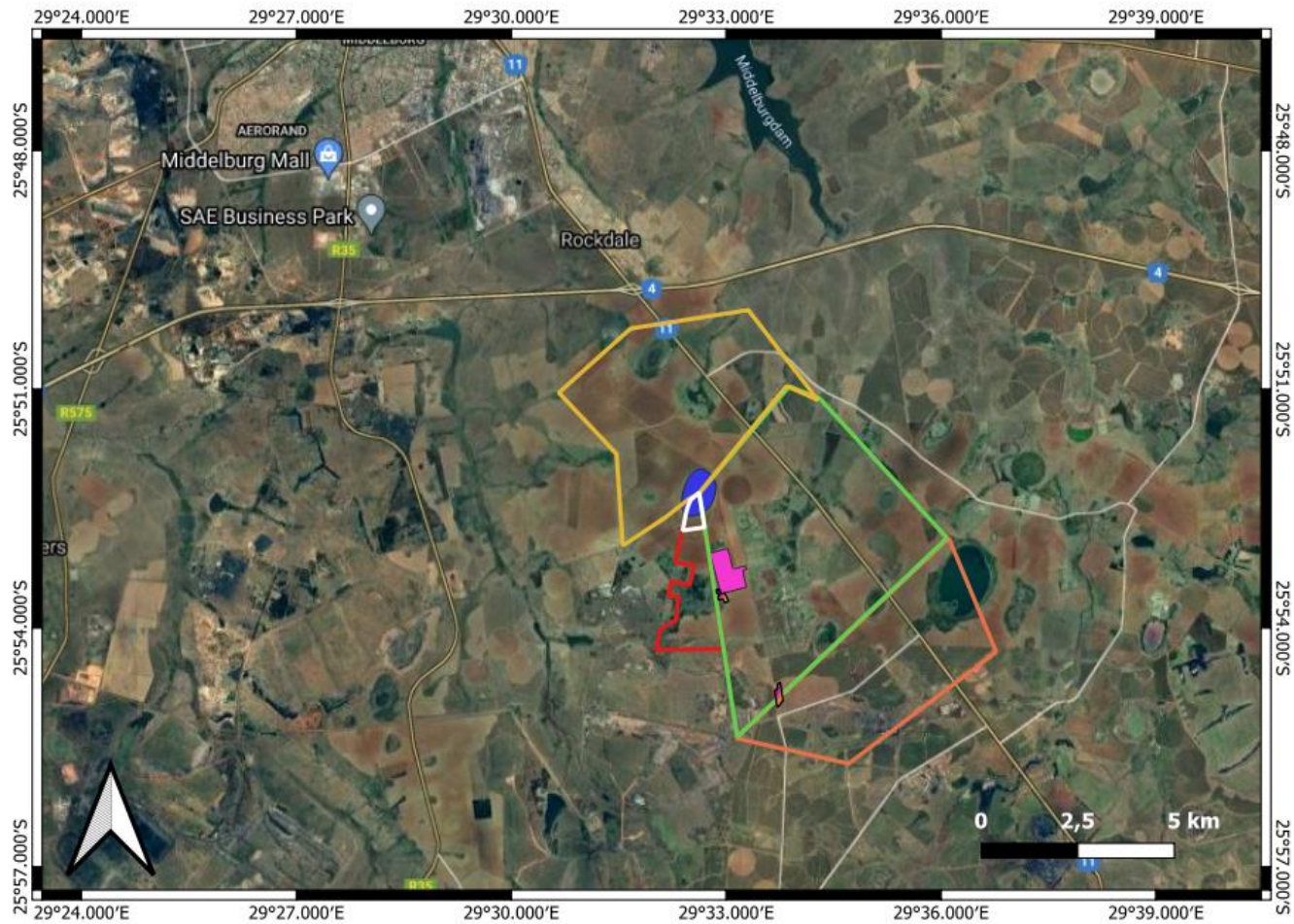


Figure 1: Google Earth Image (2021) indicating the locality of the proposed Molare Piggery Expansions on Portion 0(Re) of the farm Arendsfontein 464 JS, Portion 0(Re) of the farm Wanhoop 443 JS, Portion 0(Re) of the farm Eikeboom 476 JS and Portions 2 & 7 of the farm Klipbank 467 JS within the Jurisdiction of the Steve Tshwete Local Municipality, Mpumalanga Province.

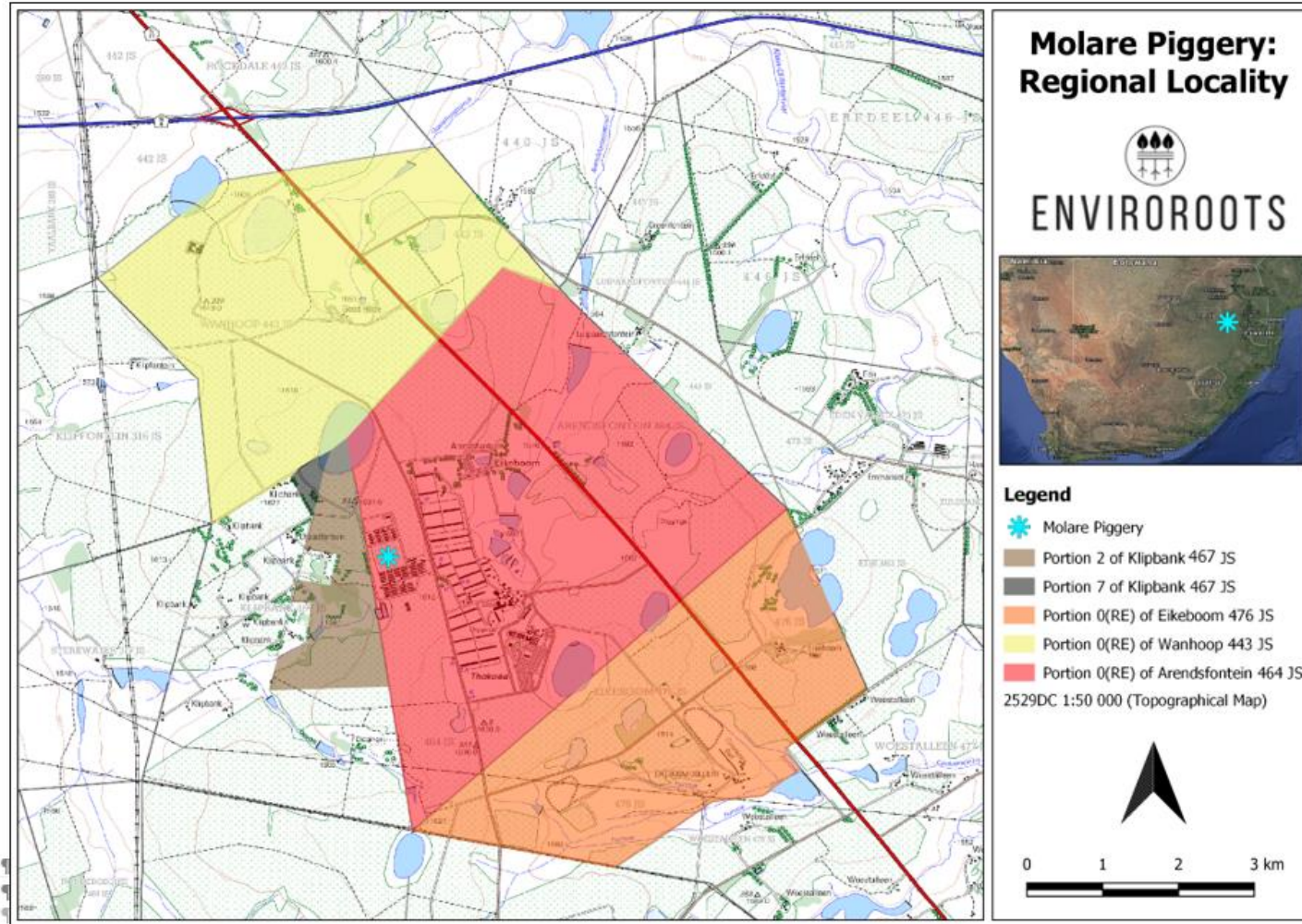


Figure 2: Location of the proposed expansions of the existing Molare Piggery infrastructure.

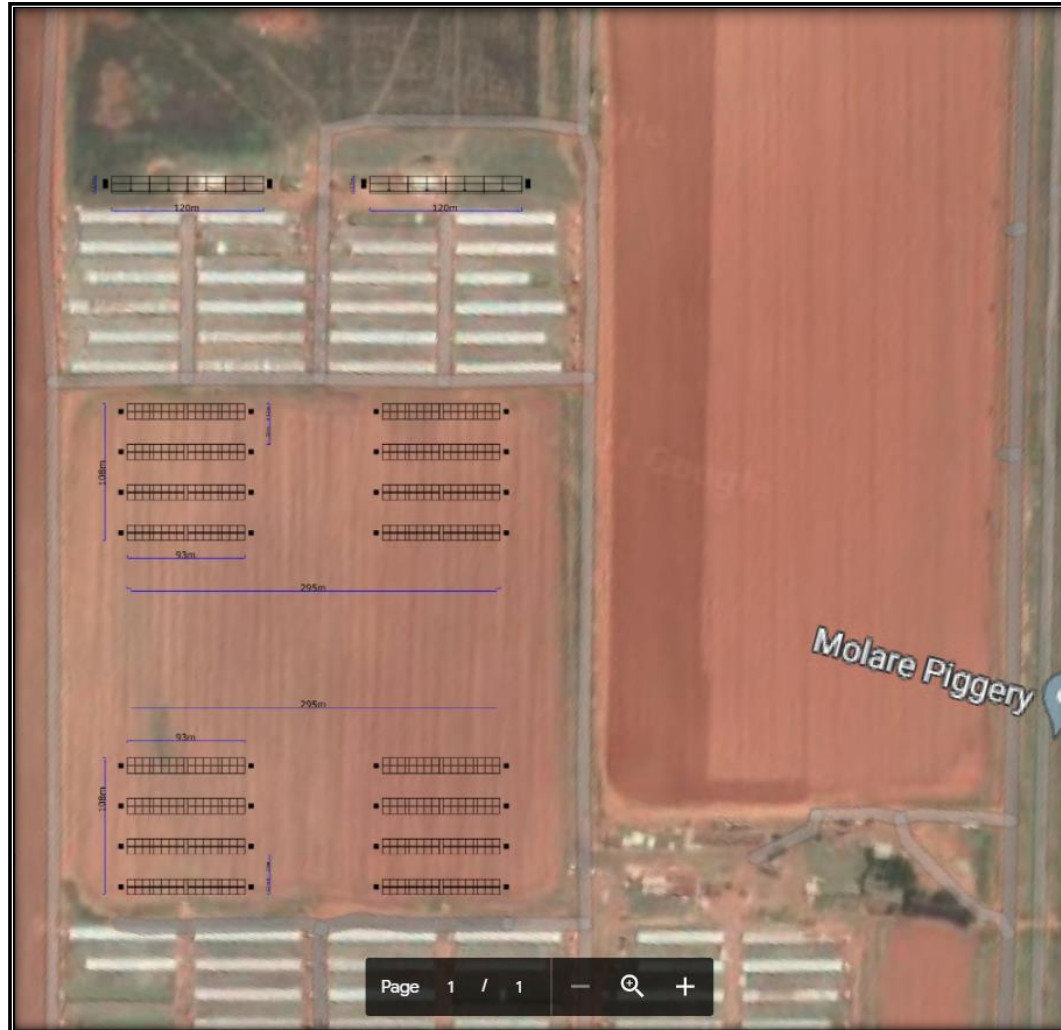


Figure 3: Proposed Molare piggery expansion

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, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

3 LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **“all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens”**.

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

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

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

GNR 982 (Government Gazette 38282, 14 December 2014) 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 m² 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 objective of a Palaeontological Impact Assessment (PIA) 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 PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

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

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

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

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements.

- Submit a comprehensive overview of all appropriate legislation, guidelines.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kmls) 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** are impacts that 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 PALAEOLOGICAL HISTORY

The proposed Molare Piggery Expansions on Portion 0(Re) of the farm Arendfontein 464 JS, Portion 0(Re) of the farm Wanhoop 443 JS, Portion 0(Re) of the farm Eikeboom 476 JS and Portions 2 & 7 of the farm Klipbank 467 JS within the jurisdiction of the Steve Tshwete Local Municipality, Mpumalanga Province is depicted on the 1: 250 000 2528 Pretoria (1978) Geological Map (Council for Geosciences, Pretoria) (**Figure 4**). The Molare Piggery expansion is underlain by rocks of the Vryheid Formation (Ecca Group, Karoo Supergroup, 290-266 million years old) as well as the Kwaggasnek Formation of the Rooiberg Group (Transvaal Supergroup 2.06 billion years old). According to the South African Heritage Resources Information System, the Palaeontological Sensitivity of the Vryheid Formation is Very High, while that of the metamorphic Rooiberg Group is Zero as it is unfossiliferous.

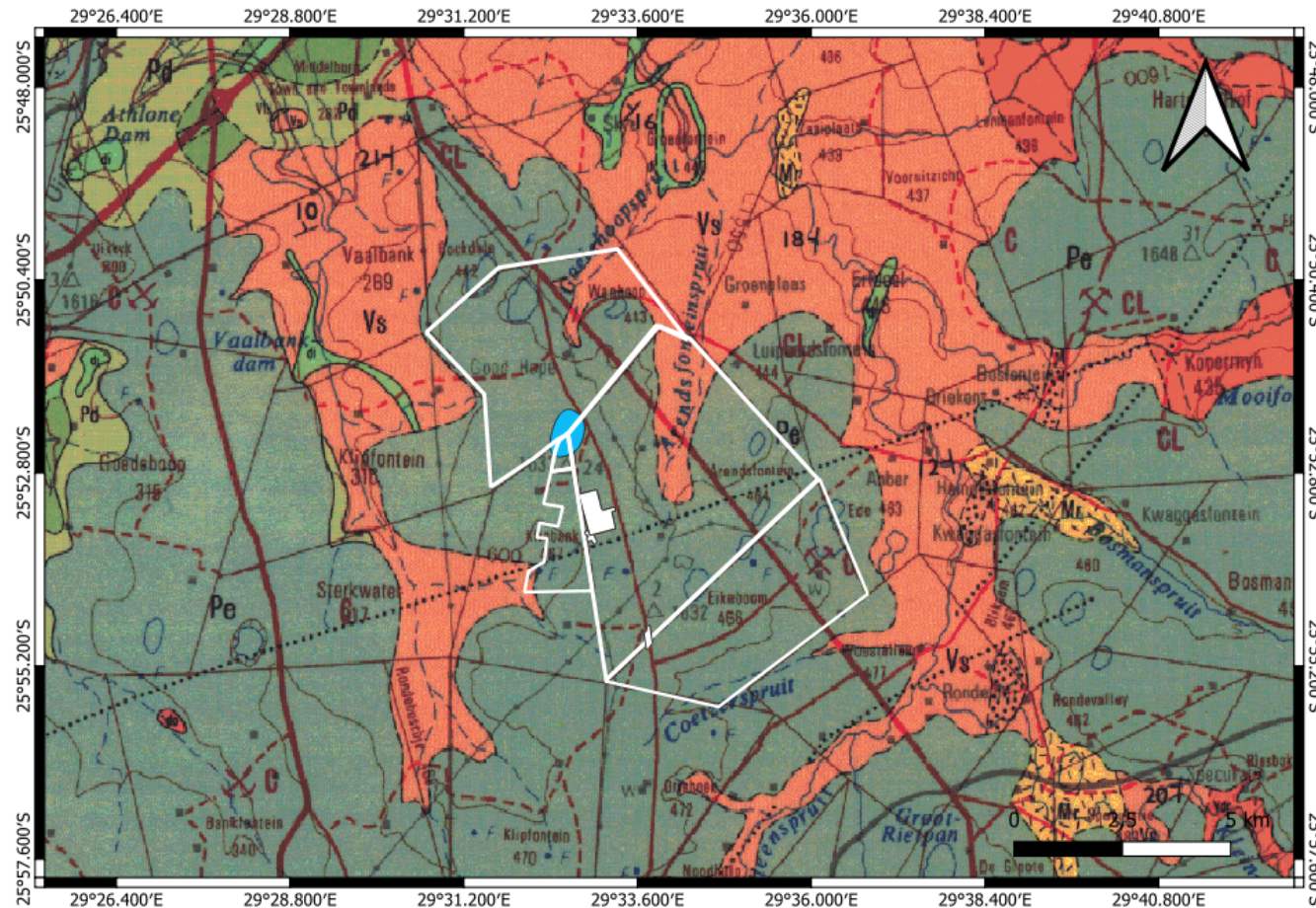


Figure 4: Extract of the 1:250 000 2528 (1978) Pretoria Geological map (Council of Geoscience) of the Molare Piggery expansion. The proposed development is underlain by the Vryheid Formation (Pe, Ecca Group, Karoo Supergroup) as well as the Kwaggasnek Formation (Vs) of the Rooiberg Group (Transvaal Supergroup).

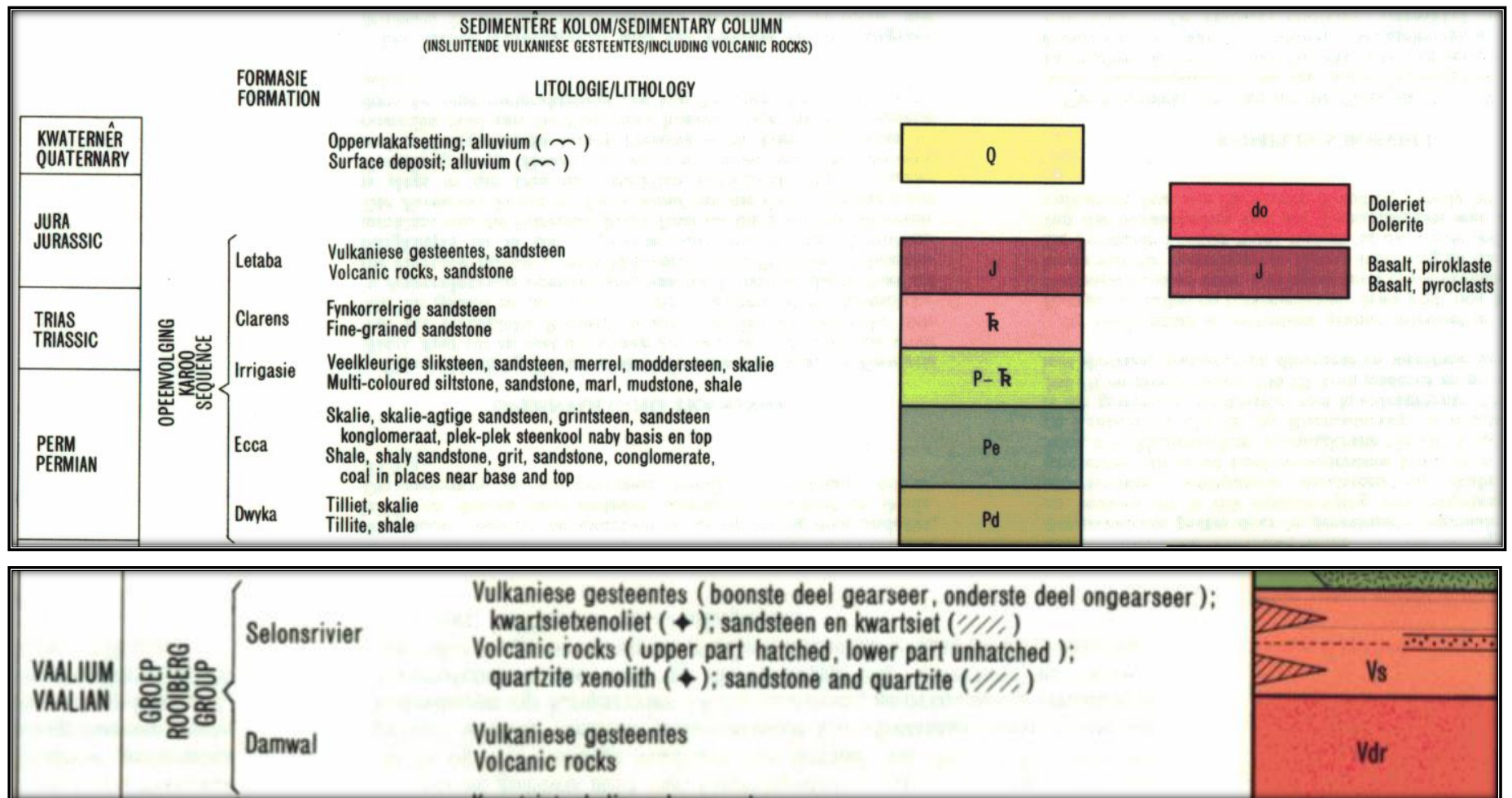


Table 2: Legend to Map and short explanation (Modified from the 1:250 000 2528 Pretoria (1978) Geological Map (Council for Geosciences, Pretoria)).

Symbol	Lithology	Stratigraphy	Age
Pe	Shale, Shaley sandstone, grit, sandstone, conglomerate, coal in places near top and bottom	Vryheid Formation, Eccca Group, Karoo Supergroup	Permian
Pd	Tillite, shale	Dwyka Group, Karoo Supergroup	Permian
di		Diabase	Vaalian to Mogolian age
Vs	Volcanic rocks quartzite xenolith	Selonsrivier Formation now Kwaggasnek Formation Rooiberg Group, Transvaal Supergroup	Vaalian

The Permian Vryheid Formation is internationally renowned for its coal deposits and is known for its rich assemblage of Glossopteris flora which is the source vegetation for this formation. The depth of the Vryheid Formation in the main Karoo Basin may be up to 500 m near Vryheid and New Castle in Kwazulu-Natal (type-locality), where the basin was at its deepest. The Vryheid Formation thins from the north-eastern part of the basin and finally wedges out towards the west, southwest and south (Johnson 2009). This formation forms a part of the Middle Ecca (Kent 1980) and contains the largest coal reserves in South Africa.

The Vryheid Formation comprises mudrock, rhythmite, siltstone and fine- to coarse-grained sandstone (pebbly in places). The Formation contains up to five (mineable) coal seams. The different lithofacies are mainly arranged in upward-coarsening deltaic cycles (up to 80m thick in the southeast). Fining-upward fluvial cycles, of which up to six are present in the east, are typically sheet-like in geometry, although some form valley-fill deposits. They comprise coarse-grained to pebbly, immature sandstones - with an abrupt upward transition into fine-grained sediments and coal seams.

The Vryheid Formation comprise of a rich assemblage of Glossopteris flora (**Figure 5**). After continental deglaciation took place Gymnospermous glossopterids dominated the peat and non-peat accumulating Permian wetlands (Falcon, 1986, Greb *et al.*, 2006).

Recent paleobotanical studies in the Vryburg Formation include that of Bordy and Prevec (2008) and Prevec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) described numerous plant fossils from this formation (e.g. *Azaniodendron fertile*, *Cyclodendron leslii*, *Sphenophyllum hammanskraalensis*, *Annularia sp.*, *Raniganjia sp.*, *Asterotheca spp.*, *Liknopetalon enigmata*, *Hirsutum sp.*, *Scutum sp.*, *Ottokaria sp.*, *Estcourtia sp.*, *Arberia sp.*, *Lidgettonia sp.*, *Noeggerathiopsis sp.*, *Podocarpidites sp.* as well as more than 20 Glossopteris species.

In the past, palynological studies have focused on the coal-bearing successions of the Vryheid Formation and include articles by Aitken (1994, 1998), and Millstead (1994, 1999), while recent studies focussed on the Witbank Coalfield were conducted by Götz and Ruckwied (2014).

Bamford (2011) is of the opinion that only a small amount of data has been published on these potentially fossiliferous deposits and that most likely good material is present around coal mines and in other areas the exposures are poor and of little interest. When plant fossils do occur, they are usually abundant. According to Bamford, it is not feasible to preserve all the sites but in the interests of science these sites ought to be well documented, researched and the collected fossils must be housed in an accredited institution.

To date no fossil vertebrates have been collected from the Vryheid formation. The occurrence of fossil insects is rare, while palynomorphs are diverse. Fish scales and non-marine bivalves have been reported. Trace fossils are found abundantly but the diversity is low. The mesosaurid reptile, *Mesosaurus* (**Figure 6**) has been found in the southern parts of the basin but may also be present in other areas of the Vryheid formation. Regardless of the rare and irregular occurrence of fossils in this biozone, a single fossil may be of scientific value as many fossil taxa are known from a single fossil.



Figure 5: *Glossopteris* leaf.



Figure 6: *Mesosaurus* sp. (National Museum, Bloemfontein specimen NMQR 3536)

The Molare Piggery expansion is also underlain by Selonsriver/ Kwaggasnek Formation of the Rooiberg Group (**Figure 8**). According to SACS (1980) the Rooiberg Group consisted of the Selons River Formation which was divided in the Klipnek Member and the Doornkloof Member. Schweitzer *et al.* (1995) correlated the Doornkloof and Klipnek Members of the Selons River Formation (SACS, 1980) with the Schrikkloof and Kwaggasnek Formations respectively, thus rendering the Selons River Formation and its members redundant. The Kwaggasnek, Schrikkloof, Damwal and Dullstroom Formations are now known as the Rooiberg Group and consist of volcanic units. Metamorphosed sediments of quartzites, mudrocks, cherts and sandstones, are present which is mainly fluvial in origin.

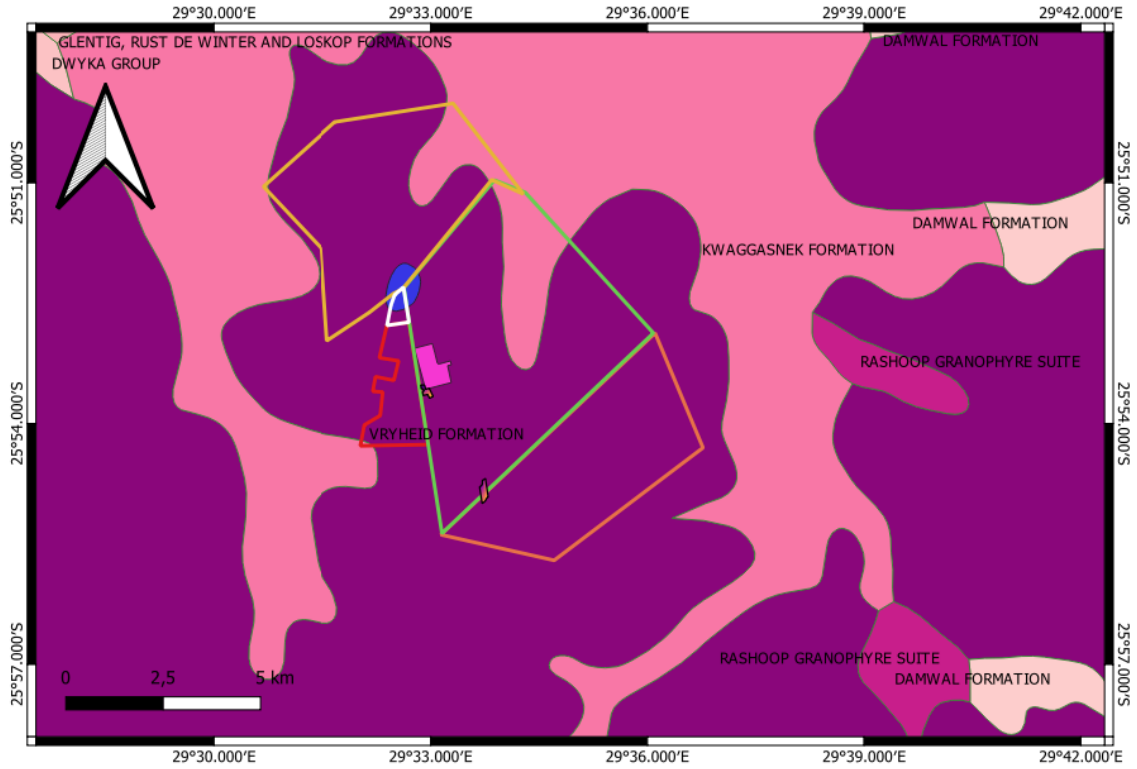


Figure 7: Surface geology of the proposed Molare Piggery Expansion. (Shape files obtained from Council of Geosciences)

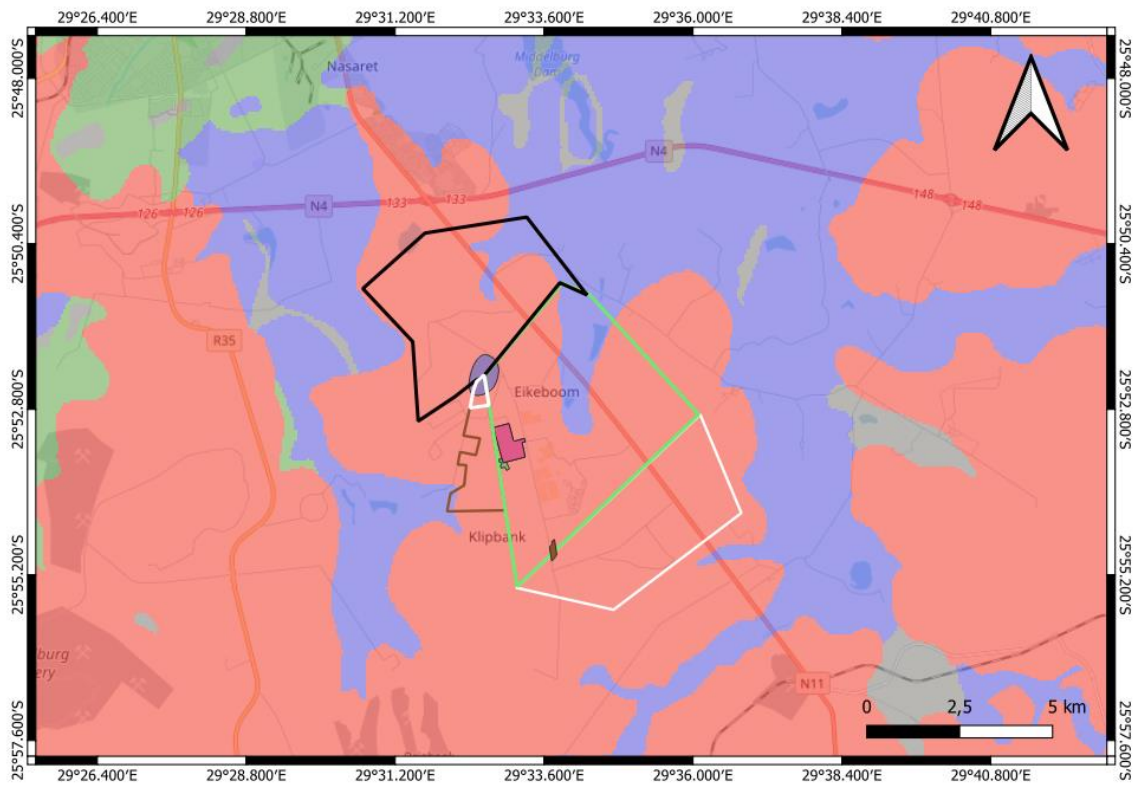


Figure 8: Extract of the 1 in 250 000 SAHRIS PalaeoMap (Council of Geosciences) indicating the location of the proposed development.

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.

According to the SAHRIS palaeo sensitivity map (**Figure 8**) there is a Very High chance of finding fossils in red (Vryheid Formation) and a zero chance in the blue area (Rooiberg Group).

6 GEOGRAPHICAL LOCATION OF THE SITE

The Proposed Molare Piggery is located about 20 km south of Middelburg via the N11 and about 25 km north of Pullens Hope. The Molare Piggery falls within the jurisdiction of the Steve Tshwete Local Municipality, Mpumalanga Province

Molare Piggery Expansion	
Arendsfontein 464 JS	Portion 0(Re)
Wanhoop 443 JS	Portion 0(Re)
Eikeboom 476 JS	Portion 0(Re)
Klipbank 467 JS	Portions 2 & 7

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.

7.1 Assumptions and Limitations

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 never been reviewed by palaeontologists and data is generally based on aerial photographs alone. 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 sourced to provide information on the existence of fossils in an area which was not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally **assumed** that exposed fossil heritage is present within the footprint. **A field-assessment will thus improve the accuracy of the desktop assessment.**

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);
- 1: 250 000 2528 (1978) Pretoria Geological map (Council of Geoscience);
- A Google Earth map with polygons of the proposed development was obtained from Enviroroots (Pty) Ltd.

9 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 21 August 2021. Although there is a Very high chance of finding fossils in the proposed development no visible evidence of fossiliferous outcrops was identified.



Figure 9: Proposed Molare piggery expansion
GPS coordinates -25,885000; 29,550833



Figure 10: View towards the dam

GPS coordinates -25,874444; 29,546389



Figure 11: *Vegetation on portion Portion 2 of Klipbank 467*

GPS coordinates -25,887778; 29,537778



Figure 12: *View on Portion 0(Re) of the farm Arendsfontein 464 JS*

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GPS coordinates -25,912500; 29,563056



Figure 13: View on Portion 0(Re) of the farm Arendsfontein 464 JS
GPS coordinates -25,890000; 29,573056



Figure 14: View Portions 2 of the farm Klipbank 467 JS
GPS coordinates -25,899167; 29,533056

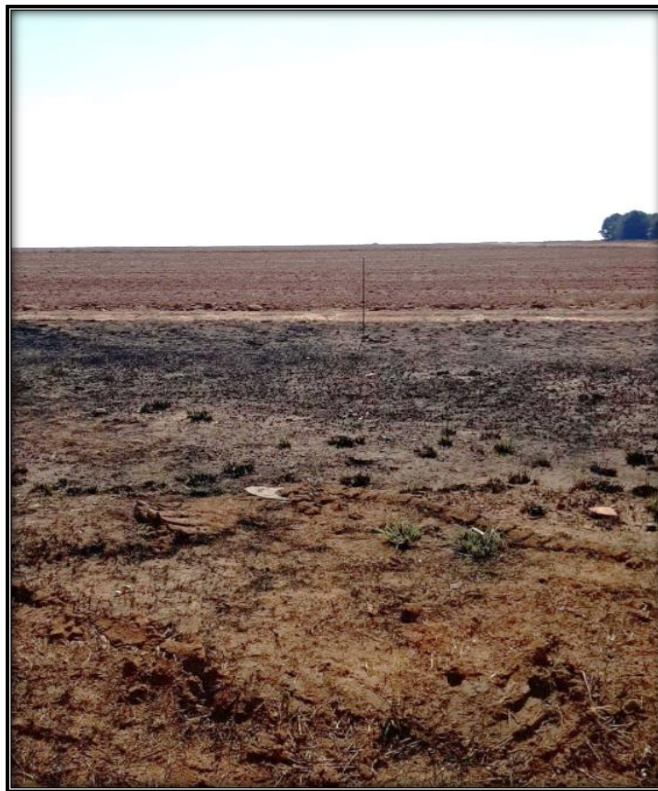


Figure 15: View on Portion 0(Re) of the farm Eikeboom 476 JS
GPS coordinates -25.906817°; 29.585967°



Figure 16: Portion 0(Re) of the farm Wanhoop 443 JS
GPS coordinates -25,850744°, 29,521939

10 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 3: 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		
<p>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:</p> <p>[(Extent (1) + probability (3) + reversibility (4) + irreplaceability (4) + duration (4) + cumulative effect (1)] x magnitude/intensity (1).</p> <p>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.</p>		
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

10.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological

materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur but are regarded as having a low probability. The significance of the impact occurring will be low.

11 FINDINGS AND RECOMMENDATIONS

The Molare Piggery expansion is underlain by rocks of the Vryheid Formation (Ecca Group, Karoo Supergroup, 290-266 million years old) as well as the Rooiberg Group (Transvaal Supergroup 2.06 billion years old). According to the South African Heritage Resources Information System, the Palaeontological Sensitivity of the Vryheid Formation is Very High, while that of the metamorphic Rooiberg Group is zero as it is unfossiliferous. The Vryheid Formation is known for its rich assemblage of Glossopteris flora which is the source vegetation for this formation, while fish scales, non-marine bivalves and trace fossils are also present in this formation.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 21 August 2021. No visible evidence of fossiliferous outcrops was identified. For this reason, an overall low palaeontological sensitivity is allocated to the development footprint. The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed development is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. 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.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the Environmental Control Officer (ECO) in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

12 CHANCE FINDS PROTOCOL

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

12.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA)**. According to Section 3 of the Act, all Heritage resources include “**all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**”.

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and 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.

12.2 Background

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

12.3 Introduction

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

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

12.4 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.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist
YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION:

- B.Sc Botany and Zoology, 1988
University of the Orange Free State

- B.Sc (Hons) Zoology, 1991
University of the Orange Free State

- Management Course, 1991
University of the Orange Free State

- M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

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

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part-time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

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