Palaeontological Impact Assessment

PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF A NEW CEMETERY, NEAR KATHU, GAMAGARA LOCAL MUNICIPALITY AND JOHN TAOLO GAETSEWE DISTRICT MUNICIPALITY, NORTHERN CAPE.

Prepared for:

PSG Heritage

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EXECUTIVE SUMMARY

The Gamagara Local Municipality proposes the development of an additional cemetery for the town of Kathu. The new Kathu Cemetery will be approximately 5 hectares in extent. The proposed development is located on the remaining extent of the farm Lyleveld 545, approximately 13 km south of central Kathu. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the cemetery on the palaeontological resources.

The proposed development site is completely underlain by sediments of the Early Precambrian, Transvaal Supergroup, Ghaap Group and Campbell Rand Subgroup. The Campbell Rand Subgroup sediments were deposited on the shallow submerged Kaapvaal Craton, approximately 2.6 to 2.5 Ga (billion years ago). The development site near Kathu consists of a flat-lying terrain and vegetation cover of grassy thornveld. The PalaeoMap (SAHRA website) indicates that the palaeontological significance of the Transvaal Group, Campbell Rand Subgroup is moderate and thus the overall impact of the proposed Cemetery development on the remaining extent of the farm Lyleveld 545 is rated as **negative moderate significance**.

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

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

CONTENTS

1 INTRODUCTION

The Gamagara Local Municipality proposes the development of an additional Cemetery in the town of Kathu and appointed Synergistics Environmental Services (Pty) Ltd (a SLR Group Company) as the independent environmental practitioner. Synergistics Environmental Services will be responsible for undertaking the necessary Basic Assessment Process as well as conducting the public participation process for the project.

The current Kathu Cemetery is located approximately 3.5 km north-east of central Kathu on the remaining extent of the farm Uitkoms 463 (immediately East of the N14 road), and falls within the Gamagara Municipality and John Taolo Gaetsewe District Municipality, in the Northern Cape. This cemetery is nearing capacity and consequently additional space is necessary. Kathu is rapidly expanding due to the growth of the Sishen Iron Ore Mine and resettlement of the Dingleton residents. The existing Kathu Cemetery is located in the protected Kathu Forest and extending the cemetery on the farm Uitkomst 463 is not possible.

An alternative location for the new cemetery has been proposed. The new cemetery will be established on the remaining extent of the farm Lylyveld 545, approximately 13 km south of central Kathu (Fig. 1). The new Kathu Cemetery will be approximately 5 hectares in extent on land owned by the SIOC. The land for the new cemetery will be transferred to the Gamagara Municipality through a land swap agreement as part of the Dingleton Resettlement project.

The main activities on site will include

- Erection of a fence to mark off the boundaries of the cemetery,
- the digging of graves and burial of coffins,
- the use of roads,
- ablution facilities,
- night-time security lighting,
- use of water (from the existing Lyleveld mine pipeline that crosses the farm), and domestic waste collection using designated bins.

Figure 1. Location of the new Kathu cemetery in relation to the nearest towns.

Figure 2. Locality map for the proposed new Kathu Cemetery

1.1 LEGISLATION

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

SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 25 OF 1999

- The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
- No person may, without a permit issued by the responsible heritage resources authority—
    - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
    - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
    - trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
    - bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
    - serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order; and/or
    - carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.

2 Objective

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

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

The objective is therefore to conduct a Palaeontological Impact Assessment, which forms of part of the Heritage Impact Assessment (HIA) and the Basic Assessment Report, to determine the impact of the development on potential palaeontological material at the site.

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

If rocks of moderate to high palaeontological sensitivity are present within the study area, a Phase 1 field-based assessment by a professional palaeontologist is necessary. Generally, damaging impacts on palaeontological heritage occur during the construction phase. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study.

When specialist palaeontological mitigation is suggested, it may take place prior to construction or, even more successfully, during the construction phase when new, potentially fossiliferous bedrock is still exposed and available for study. Mitigation usually involves the careful sampling, collection and recording of fossils as well as relevant data concerning the surrounding sedimentary matrix. Excavation of the fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. With appropriate mitigation, many developments involving bedrock excavation will have a *positive* impact on our understanding of local palaeontological heritage.

3 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

3.1 GEOLOGY

The site is completely underlain by sediments of the Early Precambrian, Transvaal Supergroup, Ghaap Group and Campbell Rand Subgroup (Fig. 3-4). The Campbell Subgroup sediments were deposited on the shallow submerged Kaapvaal Craton, approximately 2.6 to 2.5 Ga (billion years ago). This Subgroup is a very thick (1.6-2.5 km) carbonate platform succession of dolomites, dolomitic limestones and cherts with some subordinated ironstone and lenses of siltstone or shale. A variety of shallow water facies, often developed depositional cycles reflecting sea level changes, including stromatolitic limestones and dolomites, oolites, oncolites, laminated calcilutites, cherts and marls, with subordinate siliclastics (shales, siltstones) and minor tuffs (Eriksson *et al.* 2006) are recorded.

3.2 PALAEONTOLOGY

3.2.1 Stromatolites

Figure 2. Example of a well preserved stromatolite from the Archaean Era. (www.fossilmuseum.net/Tree_of_Life/Stromatolites.htm).

Stromatolites are layered mounds, columns and sheet-like sedimentary rocks. Originally they were formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of

modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. The oxygen atmosphere that we depend on was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

Stromatolites and oolites from the Transvaal Supergroup have been described by various authors (Eriksson and Altermann, 1998). Detailed descriptions of South African Archaean stromatolites are available in the literature (Altermann, 2001; Buick, 2001; and Schopf, 2006). The stromatolitic carbonates are interpreted to be intertidal (Altermann and Wotherspoon, 1995).

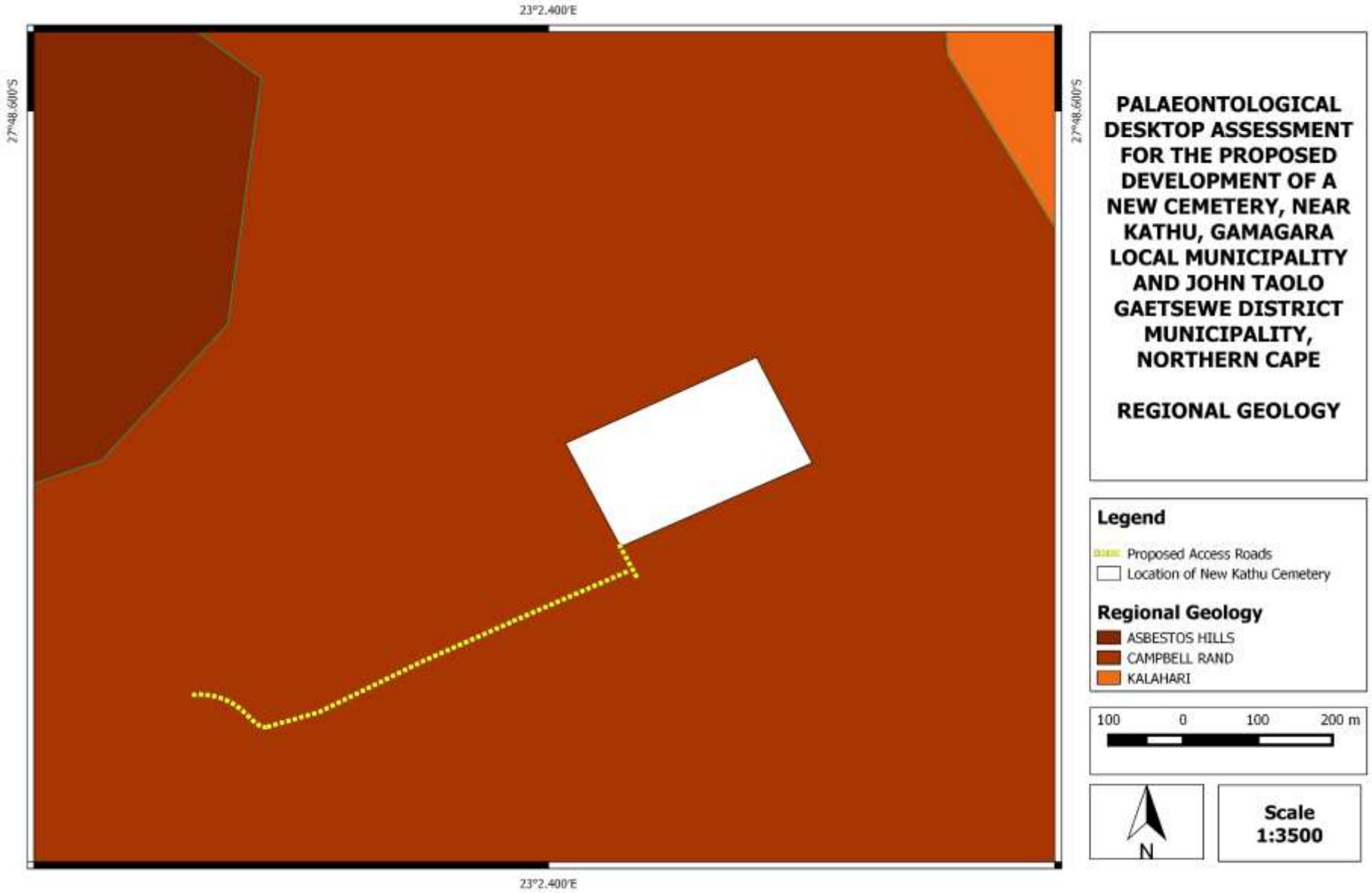

Figure 3. The surface geology of the proposed Kathu Cemetery on the remaining extent of the farm Lyleveld 545, Kathu, Northern Cape Province. The site is completely underlain by the Campbell Rand Subgroup. (Ghaap Group, Transvaal Supergroup).

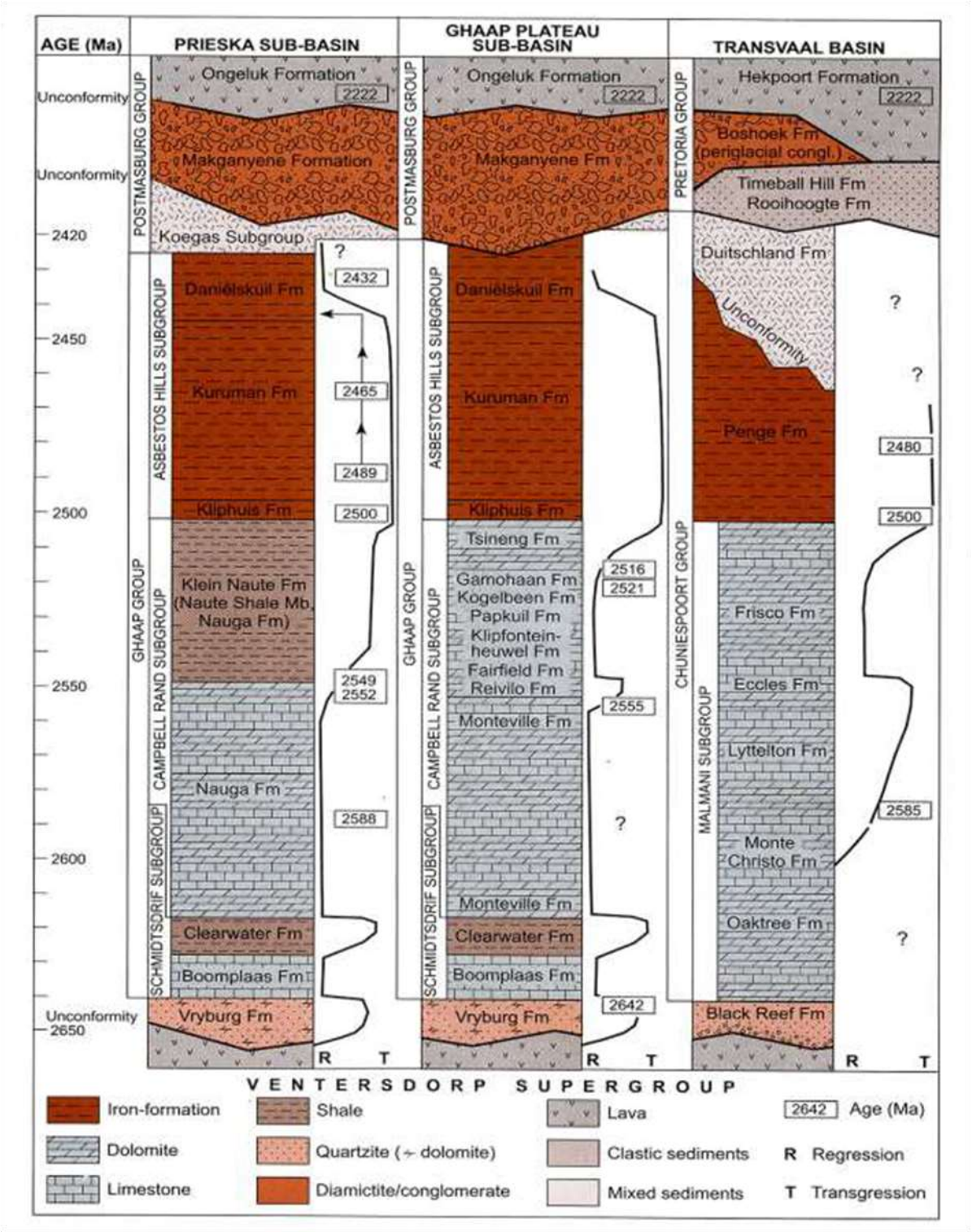

Figure 4. Stratigraphy of the Transvaal Supergroup of the Ghaap Plateau Basin. The middle column (Campbell Rand Subgroup) shows the rock units represented in the proposed site (Eriksson, *et al.* 2006).

4 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development site is located on the remaining extent of the farm Lyleveld 545, approximately 13 km south of central Kathu (Fig. 1). The new Kathu Cemetery will be just about 5 hectares in extent on land owned by the SIOC. The land for the new cemetery will be transferred to the Gamagara Municipality through a land swap agreement as part of the Dingleton Resettlement project.

4.1 ASSUMPTIONS AND LIMITATIONS

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

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

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on the possible occurrence of fossils in an unexplored area. Desktop studies therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a Palaeontological Impact Assessment may be significantly improved through field-survey by a professional palaeontologist.

5 FINDINGS AND RECOMMENDATIONS

The site located on the remaining extent of the farm Lyleveld 545, approximately 13 km south of central Kathu is completely underlain by sediments of the Early Precambrian, Transvaal Supergroup, Ghaap Group and Campbell Rand Subgroup. The Campbell Rand Subgroup is known for the presence of stromatolites (present at the surface and underground) and the impact of the development will have a medium significance on palaeontological resources. The proposed development is thus unlikely to pose a substantial threat to local fossil heritage. In Palaeontological terms the significance is rated as medium negative. Consequently, pending the

discovery of significant new fossil material here, **no further specialist studies** are considered to be necessary.

It is recommended that people digging the graves must be alert of the possibility of finding fossils. They must be trained in the skill of identifying a fossil, if present. Should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments (or somebody in management) should be alerted immediately. Such discoveries ought to be protected (preferably *in situ*) and the responsible ECO/person should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

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

5.1 METHODOLOGY FOR IMPACT ASSESSMENT

In order to ensure uniformity, a standard impact assessment methodology has been utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors, along with the equivalent quantitative rating scale for each of the aforementioned criteria, is given in *Table 1*.

Table 1: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated corridor / proposed corridor*	Incidental
2	LOW	*Study area*	Short-term
3	**MODERATE**	***Local on the study area***	**Medium-term**
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

5.1.1 Significance Assessment

The significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these, since their importance in the rating scale is very relative.

The site is underlain by the Ghaap Group (Campbell Rand Subgroup). Stromatolites are known (from the literature) to be present in the development area and the likelihood of significant fossil heritage in the Kathu area is considered to be medium.
A more detailed description of the impact significance rating scale is given in *Table 2* below.

Table 2: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	**MODERATE**	**Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts:**

		mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity is needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
	0	There is no impact at all - not even a very low impact on a party or system.

5.1.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in *Table 3*.

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

Table 3: Description of the spatial significance rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of possible impacts, and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50 km from the proposed site / corridor.
3	**Local**	The impact will affect an area up to 5 km from the proposed site.
2	**Study Area**	**The impact will affect an area not exceeding the boundary of the study area.**
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the site.

5.1.3 Temporal/Duration Scale

In order to accurately describe the impact, it is necessary to understand the duration and persistence of an impact in the environment.

The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent.

The temporal or duration scale is rated according to criteria set out in *Table 4*.

Table 4: Description of the temporal rating scale

RATING		DESCRIPTION
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium-term	The environmental impact identified will operate for the duration of life of the project.
4	Long-term	The environmental impact identified will operate beyond the life of operation of the project.
5	**Permanent**	**The environmental impact will be permanent.**

5.1.4 Degree of Probability

The probability or likelihood of an impact occurring, will be outlined in *Table 5* below.

Stratigraphic and geographical distribution of Archaean stromatolites within the Campbell Rand Subgroup has been documented in the literature. Stromatolite assemblages may be present within the development site. By taking a precautionary approach, an insignificant loss of fossil resources is expected.

Table 5: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	**Could happen**
4	Very likely
5	It's going to happen / has occurred

5.1.5 Degree of Certainty

As with all studies, it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used, as discussed in *Table 6*. The

level of detail for specialist studies is determined according to the degree of certainty required for decision-making.

Since concentrations of small to large stromatolites might occur within the site, the probability of impacts on palaeontological heritage during the construction phase is probable.

Table 6: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	**Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.**
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

5.1.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner, in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale, as described below:

$$\textit{Impact Risk} = \frac{(\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal})}{3} \times \frac{\text{Probability}}{5}$$

An example of how this rating scale is applied is shown below:

Table 7: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	Moderate	Local	Long Term	Could Happen	**Moderate**
Impact on palaeontological deposits	3	3	5	3	**2.2**

Note: The significance, spatial and temporal scales are added to give a total of 8, which is divided by 3 to give a criterion rating of 3.3. The probability (3) is divided by

5 to give a probability rating of 0.6. The criteria rating of 2.67 is then multiplied by the probability rating (0.6) to give the final rating of 2.2.

The impact risk is classified according to five classes as described in *Table 8* below.

Table 8: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	**3**	**Moderate**
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High

Therefore, with reference to the example used for heritage structures above, an impact rating of 2.2 will fall in the Impact Class 3, which will be considered to be a moderate impact.

Table 9: Final Impact Evaluation Summary

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
Impact on palaeontological deposits					
No mitigation	MODERATE	Study Area	Permanent	Could happen	
	3	2	5	3	2.00
With mitigation	LOW	Study Area	Permanent	Could happen	
	2	2	5	3	1.80

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7 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty years. She has been conducting Palaeontological Impact Assessments since 2014.

8 DECLARATION OF INDEPENDENCE

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

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