Palaeontological Impact Assessment for the proposed Mining Right Application on the Remaining Extent of Portion 1 (Paals Werf) of the farm Saxendrift 20, near Prieska, Northern Cape Province

Desktop Study (Phase 1)

For

Archaeological and Heritage Services Africa (Pty) Ltd

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Expertise of Specialist

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Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Archaeological and Heritage Services Africa (Pty) Ltd, Pretoria, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature:

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Mining Right Application on the Remaining Extent of Portion 1 (Paals Werf) of the farm Saxendrift 20, near Prieska, Northern Cape Province.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development. SAHRA requested a site visit and this was completed in June and is reported herein

The proposed site lies on the potentially fossiliferous Dwyka Group rocks, Tertiary Calcretes and Quaternary alluvium. No fossils of any kind were found on the surface or in the erosion gullies during the site visit. Nonethless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations or mining activities have commenced. As far as the palaeontology is concerned, the impact is very low and the project should be authorised.

Table of Contents

1. Background

A proposed Mining Right Application on the Remaining Extent of Portion 1 (Paals Werf) of the farm Saxendrift 20, near Prieska, Northern Cape Province, requires a palaeontological impact assessment.

The site is on the southern side of the Orange River, approximately 50 km southwest of the town of Douglas. Irrigation and the cultivation of crops occurs close to the river but the majority of the area has indigenous sparse shrubs and eroded areas adjacent to the ephemeral stream that drain into the Orange River.

A Phase 2 (site visit) Palaeontological Impact Assessment was requested for the Saxendrift Mining Right Application project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and updated from the site visit, and the latter is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6
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 5
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity 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	Sections 6, 8
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 of 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 gazetted 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.	N/A

Figure 1: Google Earth map of the general area to show the relative land marks. The Farm Saxondrift boundary is shown by the black polygon.

Figure 2: Google Earth Map of the proposed MRA on Portion 1 of Farm Saxondrift 20 with the section shown by the black outline.

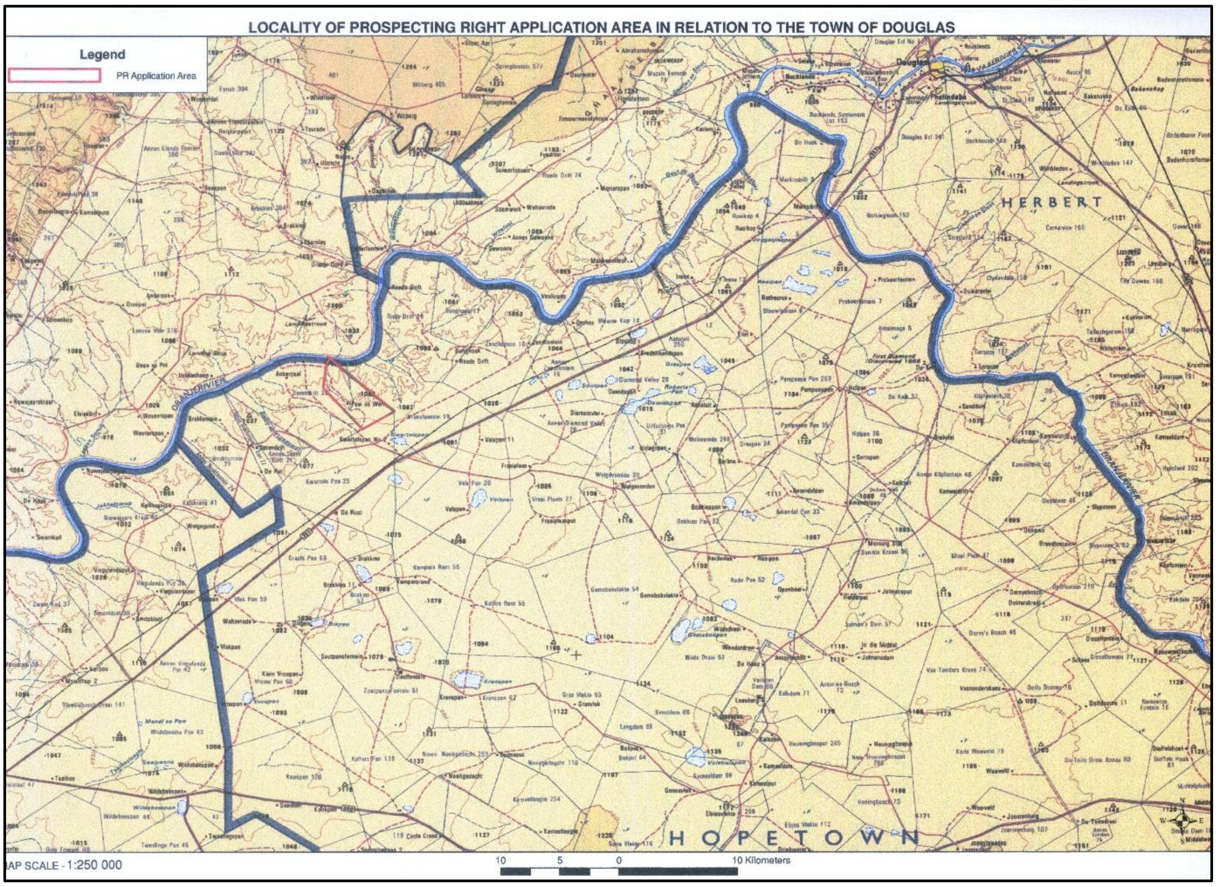

Figure 3: Annotated 1: 250 000 topographic map to show the project area in relation to the nearest large town, Douglas.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

The project lies in the southern margin of the Griqualand West Basin that has sediments of the Transvaal Supergroup and the north-western margin of the younger Karoo Basin where the basal sediments are exposed. The old geological sediments are overprinted by the Cretaceous palaeo-river downcutting (and source of the alluvial diamonds) followed by the infilling of Karoo sediments. All of these rocks have been covered by much younger aeolian sands and river alluvium from the Tertiary to Quaternary palaeo-erg.

The Late Archaean to early Proterozoic **Transvaal Supergroup** is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas. There are two Formations in the Schmidtsdrift Subgroup and occur in both of the sub-basins of the Griqualand West Basin. The lower Boomplaas Formation comprises stromatolitic and oolitic platform carbonates. Only the upper 100m is visible in surface outcrops but it extends another 185m in borehole core (Beukes, 1979, 1983). They represent deep lagoonal deposits, transported oolites and carbonate shelf rocks. The upper Clearwater Formation comprises shales, tuffites and BIF-like cherts and is interpreted as a transgressive deposit over the Boomplaas Formation (ibid; Eriksson et al., 2006).

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled. This group has been divided into two formations with Elandsvlei Formation occurring throughout the basin and the upper Mbizane Formation occurring only in the Free State and KwaZulu Natal (Johnson et al., 2006).

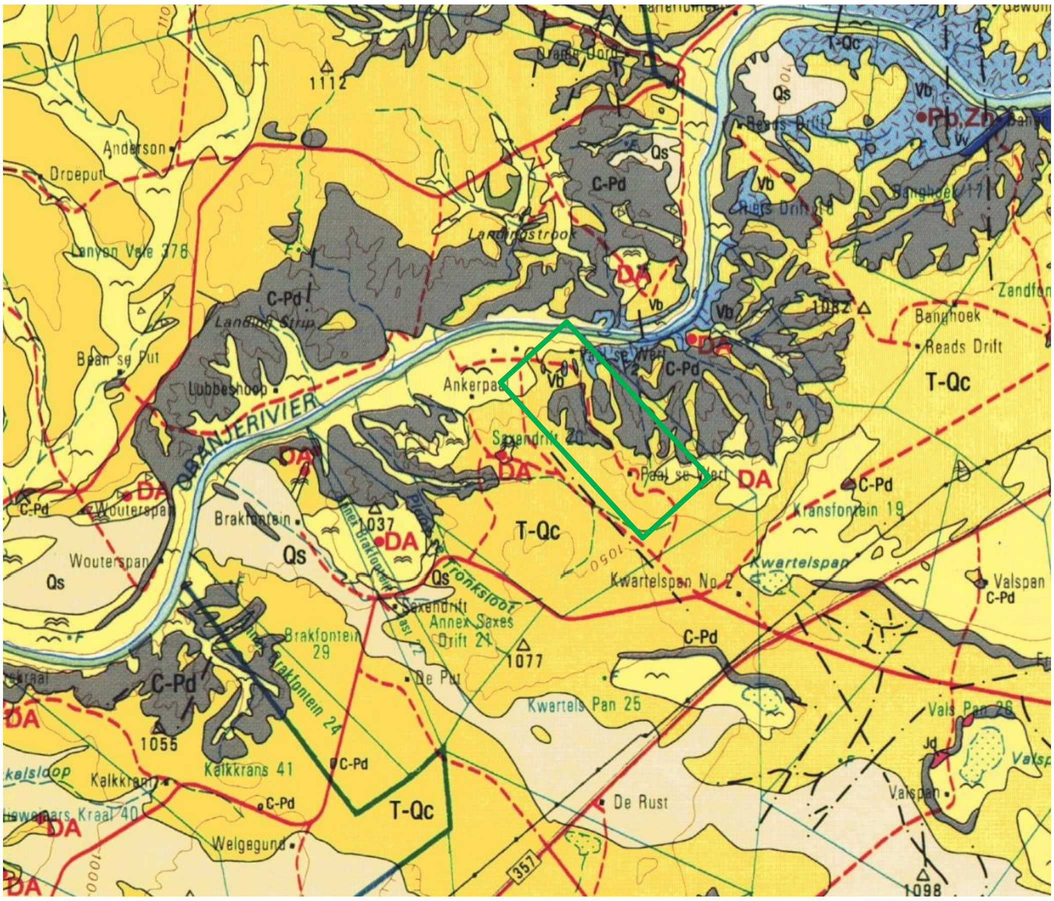

Figure 4: Geological map of the area around the Farm Saxondrift 20 with the location of the proposed project indicated within the green rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2922 Prieska.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary alluvium	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Qs	Quaternary alluvium and sand	Sand and sandy soil	Neogene, ca 2.5 Ma to present
Qg	Gordonia Fm,	Aeolian and dune sand	Neogene, ca 2.5 Ma to present
T-Qc	Tertiary- Quaternary calcrete	Calcrete	Tertiary to Quaternary
C-Pd	Dwyka Group, Karoo SG	Tillites, sandstone, mudstone, shale	Late Carboniferous to Early Permian, ca 300 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vb	Boomplaas Fm, Schmidtsdrift Subgroup, Ghaap Group, Griqualand /west sequence of the Transvaal SG	Oolitic, stromatolitic and algal-mat limestone; interbedded flagstone and quartzite	Palaeoproterozoic, Ca 2640 Ma

According to de Wit (1999) and Partridge et al., (2006) the history of post-Gondwana major rivers in the western part of South Africa is very important because these rivers were instrumental in the establishment of diamondiferous placers along the west coast of southern Africa. The evolution of the drainage system that developed after breakup of west Gondwana can be viewed in three timeslots: the middle to Late Cretaceous, the early to middle Cenozoic, and the late Cenozoic periods.

During the middle to Late Cretaceous there were two main river systems, the southern Karoo River, and the northern Kalahari River that was closer to the present day Orange River. Erosion by the palaeo rivers released most of the diamonds from the Cretaceous kimberlites in central South Africa at different times and they were transported by the Karoo River to the coast initially, and the Kalahari River later.

The **Quaternary Kalahari sands** form an extensive cover of much younger deposits over much of the Northern Cape Province and Botswana. Based on the early works of Leicester King, Partridge and Maud (1987, 2000) developed a model of three African Erosion Surfaces for southern Africa, from the Cretaceous to the Pliocene. During the Cretaceous Africa was very high, averaging about 2500-2000m above sea level but the rifting apart of Gondwanaland and formation of the Atlantic and Indian Oceans, coastal erosion was rapid and the escarpment rapidly receded about 120km inland along the east and south coasts, but only 50km along the west coast. The newly exposed surface was called the African Erosion Surface. Their model has been challenged and modified by a number of researchers (Burke, 2011; Braun et al., 2014) who propose that mantle plumes caused uplift of the continent during the late Cretaceous, followed by erosion and further uplift about 30-20 million years ago, The newer interpretations have been followed here.

Haddon and McCarthy (2005) proposed that the Kalahari basin formed as a response to down-warp of the interior of the southern Africa, probably in the Late Cretaceous. This, along with possible uplift along epeirogenic axes, back-tilted rivers into the newly formed Kalahari basin and deposition of the Kalahari Group sediments began. Sediments included basal gravels in river channels, sand and finer sediments. A period of relative tectonic stability during the mid-Miocene saw the silcretisation and calcretisation of older Kalahari Group lithologies, and this was followed in the Late Miocene by relatively minor uplift of the eastern side of southern Africa and along certain epeirogenic axes in the interior. More uplift during the Pliocene caused erosion of the sand that was then reworked and redeposited by aeolian processes during drier periods, resulting in the extensive dune fields that are preserved today.

Tertiary calcretes cover large parts of the Northern Cape but they are difficult to date and there are several schools of thought (see Partridge et al., 2006). Nonetheless, it is accepted that calcretes form under alternating cycles humid and arid climatic conditions in strata that have calcium carbonate (Netterberg, 1969). More recent research using geophysical techniques to measure uplift of the continent during the Cretaceous and tertiary, combined with the fossil record (Braun et al., 2014) suggest that there were two predominant humid periods during the Tertiary. The whole of the Eocene (56-33 Ma) and a short period during the early Miocene (ca 20-19 Ma) were humid according to their estimation. It is possible that the Northern Cape calcretes formed during one of these periods.

Overlying many of these rocks are loose sands and sand dunes of the Gordonia Formation, Kalahari Group of Neogene Age. The Gordonia Formation is the youngest of six formations and is the most extensive, stretching from the northern Karoo, Botswana, Namibia to the Congo River (Partridge et al., 2006). It is considered to be the biggest palaeo-erg in the world (ibid). The sands have been derived from local sources with some additional material transported into the basin (Partridge et al., 2006). Much of the Gordonia Formation comprises linear dunes that were reworked a number of times before being stabilised by vegetation (ibid).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 5. The site for mining is in the Dwyka Groups rocks (green; moderate sensitivity) and the Tertiary-Quaternary calcretes (orange, highly sensitive).

The Dwyka Group tillites and mudstones can trap fossils that were caught up in the ice sheets or glaciers and dropped when the ice melted, therefore these fossils tend to transported fragments of more robust fossils such as silicified wood, invertebrate remains and rarely *Glossopteris* leaves or associated flora. Two rare occurrences are mentioned by Anderson and McLachlan (1976) near Strydenburg which is to the northeast of this site. There are no other reports. According to Johnson et al. (2006), the fossils are only likely to be found in mudstone facies of the Dwyka Group.

Exploration and research along the palaeo-rivers of Southern Africa, now only present as abandoned palaeochannels, or captured by the present day rivers, the Vaal and Orange Rivers in this case, the gravels and sands might include transported robust and fragmentary fossils. Examples of these are heavy bone fragments and silicified wood fragments, as well as diamonds (de Wit, 1999; de Wit et al., 2000).

The Tertiary calcretes can trap fossils and artefacts when associated with palaeo-pans or palaeo-springs (Partridge et al., 2006). Where deflation has occurred, for example along the west coast of South Africa, any trapped materials in the different levels can be concentrated in the depo-centre of the pan or dune and thus it can be challenging to interpret the deposit (Felix-Henningsen et al., 2003).

Palaeo-pans and palaeo-springs are visible in satellite imagery because of their topography and often are associated with lunette dunes. Vegetation changes are also common. No such features are seen in the Google Earth images. Aeolian sediments that cover most of the region, do not preserve fossils because they have been reworked and windblown.

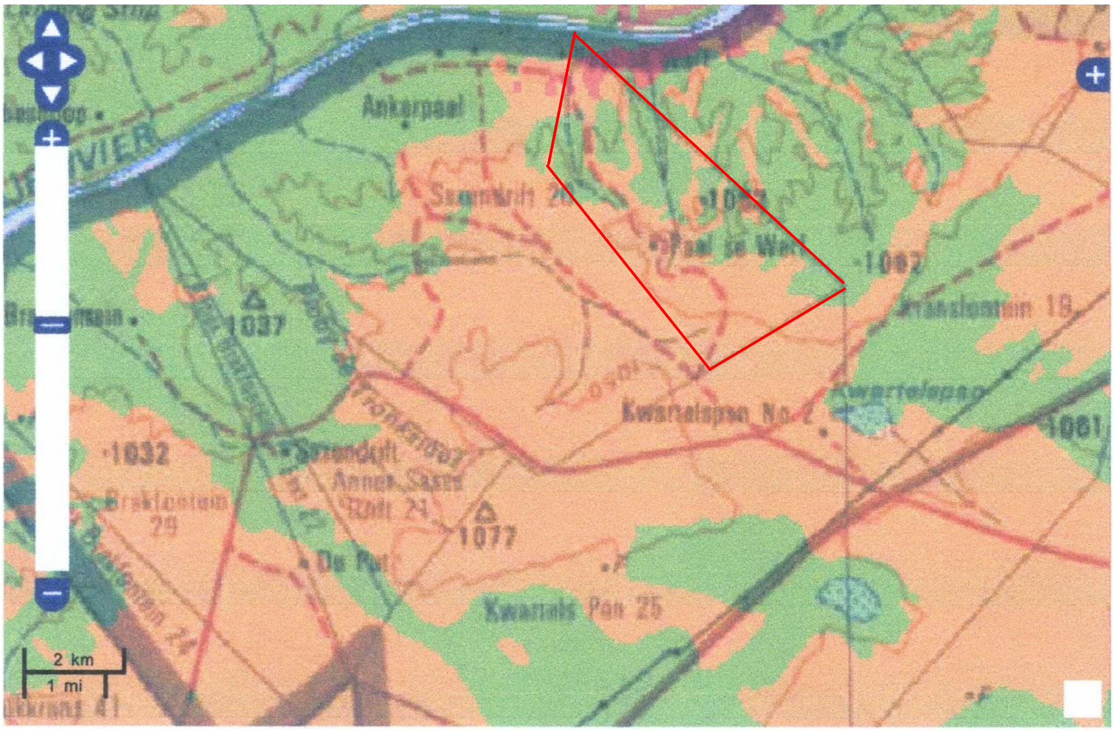

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed MRA on Portion of Farm Saxondrift 20 shown within the red rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

4. 3iii Site visit observations

The area was walked down in June 2022 and the surface rocks, natural cutting provided by erosion channels and ridges were targeted as they are likely to show the underlying rocks and any fossils. A selection of site photographs of representative landscapes and the GPS locations are provided in Table 3 and Figures 6 -18 below.

No fossils of any kind were seen in the erosion channels or on the ground surface. Transported Dwyka Group pebbles were seen in places but there were only clasts and no fossils were seen amongst them.

Table 3: Site Visit stops with GPS coordinates, observations and relevant site photographs.

Stop No; GPS	Field observations	Figure
General view	View north along a stream cutting through glacial tillites deposits.	6A

General view	Another view of the glacial tills a stream eroding through them (middle ground).	6B
Stop 1 29°19'18.90"S 23°20'16.50"E	Southwestern part of the property, exposures of calcrete hardpan and surface waste. No fossils or fragments.	7
Stop 2 29°19'09.10"S 23°19'57.30"E	Southeastern part of the property, red gravels overlying calcrete hardpan.	8
Stop 3 29°18'19.10"S 23°19'37.60"E	Stream eroding through the glacial tills, profile of stream side (the gravel) and shale streambed.	9
Stop 4 29°18'13.80"S 23°19'33.10"E	Valley side of a stream cutting through glacial till; probably a shale deposit. No fossils in shale or with tillites.	10
Stop 5 29°18'15.80"S 23°19'32.60"E	Red-brown gravels over the glacial till near the southern edge of the tillite deposits.	11
Stop 6 29°17'41.40"S 23°19'02.60"E	Profile of a stream side in the northern part of the property shows glacial gravels possibly reworked into the modern alluvial gravels.	12
Stop 7 29°17'42.80"S 23°18'48.70"E	Northern shoulders of a stream shows a calcareous mantle with rocks embedded.	13
Stop 8 29°17'24.00"S 23°19'04.10"E	Northern part of the property. A deeply incised section of a stream shows a calcrete upper horizon and ?shale at the bottom.	14
Stop 9 29°16'53.00"S 23°18'40.20"E	An exposure of calcrete hardpan, calcrete and red-brown gravel waste. No fossils.	15
Stop 10 29°18'10.90"S 23°19'15.30"E	Northern part of the property. Streamside shows probably alluvially reworked or glacially deposited gravels. No fossils	16
Stop 11 29°18'11.20"S 23°19'18.70"E	Red gravels laid over the glacial till in the northern part of the property.	17
Stop 12 29°18'47.90"S 23°19'31.70"E	Central-western part of the property, calcrete waste No fossils.	18

Figure 5: General view to the north.

Figure 6: General view of central part.

Figure 7: Stop 1 - Southwestern part of the property, exposures of calcrete hardpan and surface waste

Lat: 29°19'18.90"S	Long: 23°20'16.50"E

Figure 8: Stop 2 - South-eastern part of the property, red gravels overlying calcrete hardpan

Lat: 29°19'09.10"S	Long: 23°19'57.30"E

A

Figure 9 A, B: Stop 3 - Stream eroding through the glacial tills, profile of stream side (the gravel) and shale streambed

Lat: 29°18'19.10"S	Long: 23°19'37.60"E

A

Figure 10A, B: Stop 4 - Valley side of a stream cutting through glacial till; shale deposit	
Lat: 29°18'13.80"S	Long: 23°19'33.10"E

11A

Figure 11A, B: Stop 6 - Red-brown gravels over the glacial till near the southern edge of the tillite deposits

Lat: 29°18'15.80"S	Long: 23°19'32.60"E

12A

Figure 12A, B: Stop 6 - Profile of a stream side in the northern part of the property shows the gravels

Lat: 29°17'41.40"S	Long: 23°19'02.60"E

Figure 13: Stop 7 - Northern shoulders of a stream shows a calcareous mantle with rocks embedded

Lat: 29°17'42.80"S	Long: 23°18'48.70"E

Figure 14A, B: Stop 8 - Northern part of the property. A deeply incised section of a stream shows a calcrete upper horizon and shale at the bottom

Lat: 29°17'24.00"S	Long: 23°19'04.10"E

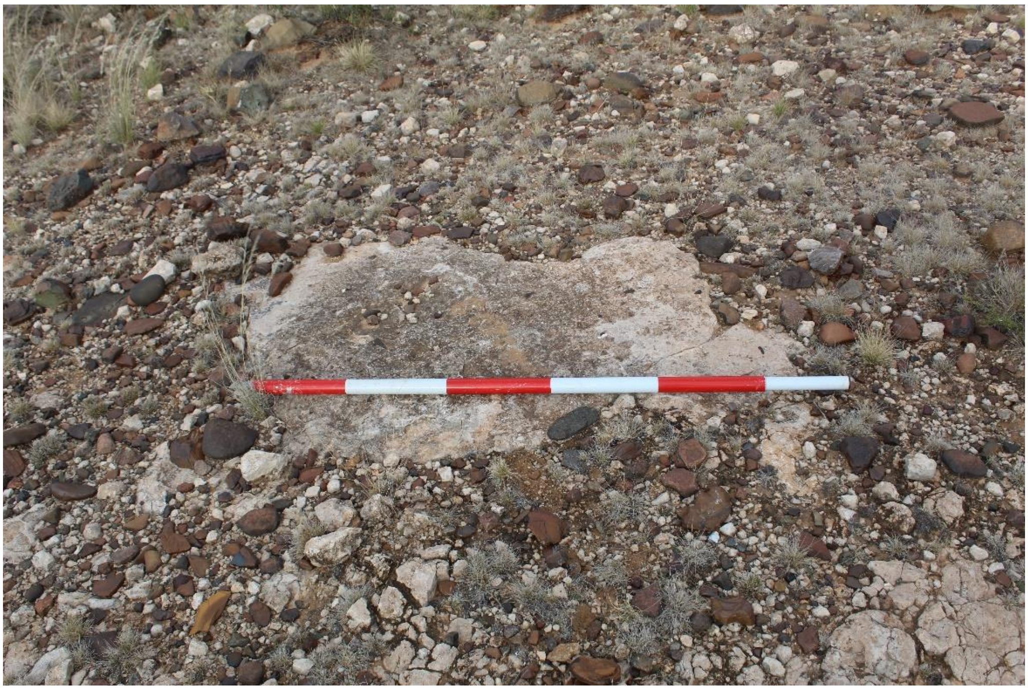

Figure 15: Stop 9 - An exposure of calcrete hardpan, calcrete and red-brown gravel waste

Lat: 29°16'53.00"S	Long: 23°18'40.20"E

16A

Figure 16A, B: Stop 10 - Northern part of the property. Streamside shows glacially deposited gravels

Figure 17: Stop 11- Red gravels laid over the glacial till in the northern part of the property.

Lat: 29°18'11.20"S	Long: 23°19'18.70"E

Figure 18: Stop 12 - Central-western part of the property, calcrete waste	
Lat: 29°18'47.90"S	Long: 23°19'31.70"E

5. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table :

Table 4a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.

	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 4b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Transported sands do not preserve fossils; only traps such as palaeo-pans or palaeo-dunes in sands or calcrete might preserve fossils. So far there are no records from the Dwyka Group or Tertiary-Quaternary sands and calcrete of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be fossils trapped in palaeo-pan or palaeo-dunes, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area as there is no evidence of traps. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age to contain fossils but there is no evidence of features such as palaeo-pans or palaeo-dunes to trap any fossils. Furthermore, the material to be mined is the sands for diamonds and this does not preserve fossils. However, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

6. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and only if there such features as palaeo-pas or palaeo-dunes to trap any fossil plant, insect, invertebrate or vertebrate material would any occur in the area. The sands of the Quaternary period would not preserve fossils.

7. Recommendation

Based on the site visit and walk through there are no surface fossils and no fossils in the eroded gullies. This confirms the previous assertion and the lack of any previously recorded fossils from the area, that it is extremely unlikely that any fossils would be preserved in the Dwyka Group tillites and sandstones or the sands and calcretes of the Tertiary-Quaternary. There is a very small chance that fossils occur below ground and also may occur in features such as palaeo-pans or palaeo-dunes that could trap fossils are present as no such feature is visible in the satellite imagery. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the miners or environmental officer, or other responsible person once mining has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, therefore, as far as the palaeontology is concerned, the project should be authorised and a mining permit granted.

8. References

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9. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling / mining activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, invertebrates) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 19, 20). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

10. Appendix A – Examples of fossils from the Dwyka Group and Tertiary-Quaternary

Figure 19: Photographs of fossils from Dwyka Group sediments.

Figure 20: Photographs of robust but fragmentary fossils that have been recovered from fluvial deposits of the Quaternary.

11. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2022

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.
NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

iii) Professional qualifications
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative

ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees
All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	11	3
PhD	11	6
Postdoctoral fellows	15	1

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 45 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12-20 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor Open Science UK: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals
Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic, Leakey Foundation

x) Palaeontological Impact Assessments
Selected from the past five years only – list not complete:

- Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC

- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.