Palaeontological Impact Assessment for the Mining Rights Application for Farm Groot Derm 10, near Alexander Bay, Northern Cape Province

DESKTOP STUDY (PHASE 1)

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

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 Mining Rights Application by Coptra-SA (Pty) Ltd on a portion of the Remaining Extent and Portion 3 of Farm Groot Derm 10, Namaqualand, about 10 km north east of Alexander Bay, 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.

The site lies predominantly on the non-fossiliferous intrusive volcanic rocks of the Neoproterozoic Gariep Subgroup but along the Orange River there are diamondifererous gravels (Oligocene to Pliocene) that have a moderate palaeosensitivity as they could contain transported fossils from farther upstream. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological assessment is required unless fossils are found by the Environmental Officer, or other designated responsible person once mining activities commence. As far as the palaeontology is concerned, the project may be authorised.

Table of Contents

1. Background

Coptra-SA (Pty) Ltd is applying for Mining Rights, in terms of Regulation 2(2) of the MPRDA, Act 26 of 2002, on a Portion of the Remaining Extent of the Farm Groot Derm 10 and Portion 3 (Beauvallon) of the Farm Groot Derm 10) near Alexander Bay in the Ritchtersveld Local Municipality, Northern Cape (Figures 1 and 2).

A Palaeontological Impact Assessment was requested for the Groot Derm 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 is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	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 2
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
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 5

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 4
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 if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

Figure 1: Google Earth map of the area on Farm Groot Derm 10 for a Mining Rights Application, with the section shown by the red outline. Map supplied by Matenga.

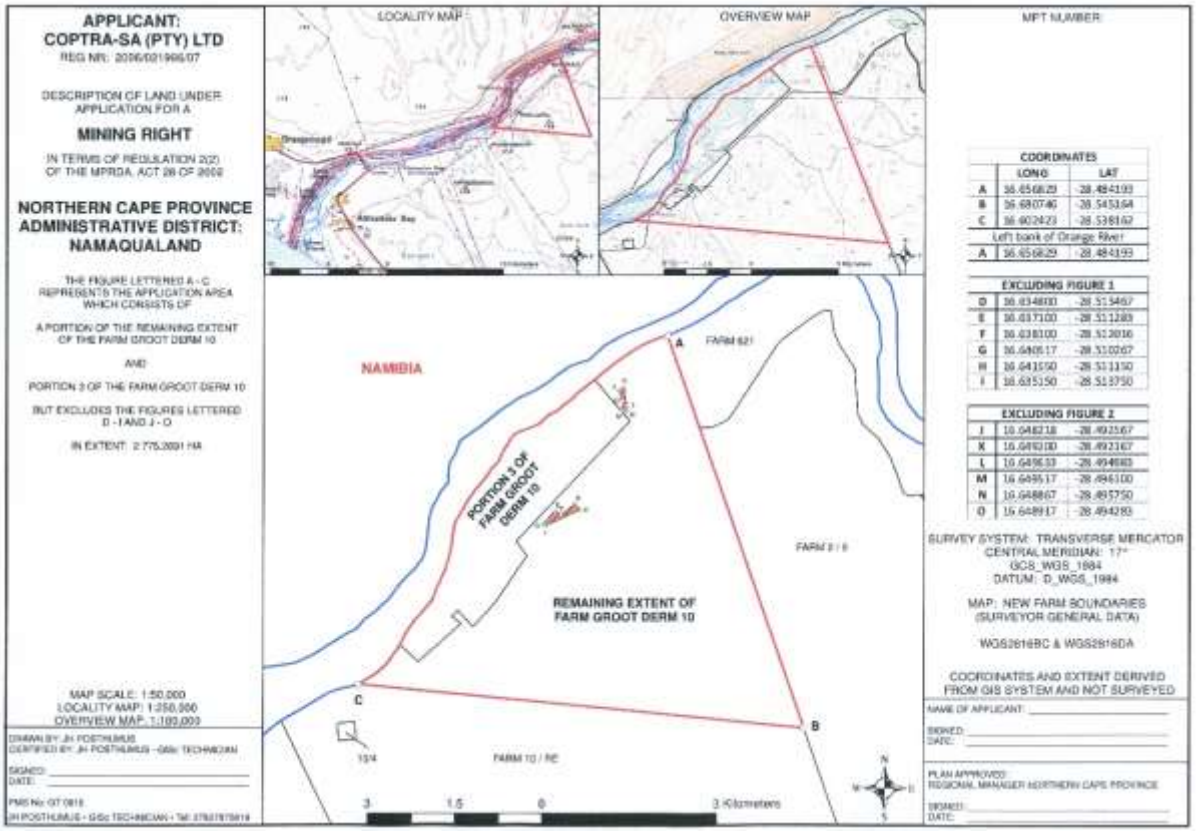

Figure 2: Detailed maps showing the location for the Mining Rights Application.

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 (*not 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 (*not 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 (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

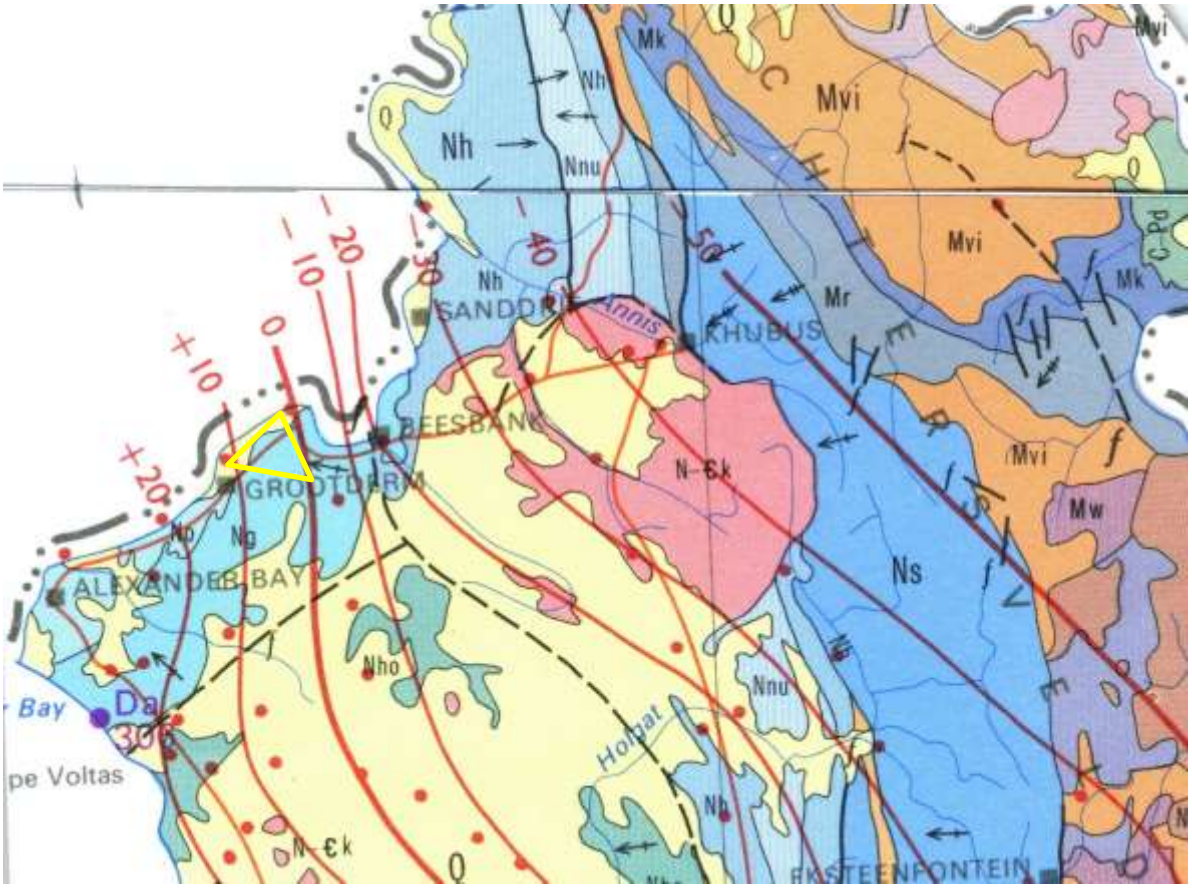

Figure 3: Geological map of the area around the Farm Groot Derm 10.The location of the proposed Mining Rights is indicated within the yellow triangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map.

Table 2: Explanation of symbols for the geological map and approximate ages (Gresse 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	Tertiary to Quaternary sands	Gravel, alluvium, sand, calcrete	Oligocene-Miocene to Neogene, ca 2.5 Ma to present
Nho	Holgat Fm, Port Nolloth Group, Gariep SG	Schist, andesite, basalt	Precambrian, Neoproterozoic ca 770 – 720 Ma
Ns	Stinkfontein Subgroup, Port Nolloth Group, Gariep SG	Meta-arenite, conglomerate	Precambrian, Neoproterozoic ca 770 – 720 Ma

Symbol	Group/Formation	Lithology	Approximate Age
No	Oranjemund Fm, Marmora Terrane, Gariep SG	Meta-arenites, metavolcanic rocks	Precambrian, Neoproterozoic ca 770 – 720 Ma
Ng	Groot Derm Fm, Marmora Terrane, Gariep SG.		Precambrian, Neoproterozoic ca 770 Ma

The rocks in this western part of South Africa belong to the Namibian Neoproterozoic to Early Cambrian Successions, the Gariep Supergroup. They represent intrusive volcanic rocks along a tectonically active north-south line and originated in an oceanic intraplate environment, such as an oceanic island or seismic ridge (Gresse et al., 2006). These rocks do not preserve fossils because they are volcanic in origin.

Today the Orange River drains the central part of southern Africa into the Atlantic Ocean in the west but the route of this river has not remained the same over time (de Wit, 1999; de Wit et al., 2000; Haddon and McCarthy, 2005). During the Cretaceous there were two major westward-draining rivers, the northerly on called the Kalahari River that exited where the Orange River does today, and the southerly Karoo River that drained the central Highveld and exited where the Olifants River does today (Figure 3). Subsequent tectonic uplift of the continent in the Late Cretaceous, and altered drainage has led to one river capturing another. By the Miocene, the capture of the middle Orange by the lower Orange River had already occurred (de Wit, 1999), and de Wit et al. (2000) believe that the Orange River has followed its present course since at least the late Oligocene. The terraces along the lower Orange River, therefore, represent different times and levels of the river, and deposits from different distant sources.

The section of the Orange River at Groot Derm has, therefore, been in place since at least the Oligocene period. There was a pluvial phase in the middle Miocene that likely scoured out the river valley deposits and deposited new material, based on fossil material (Pickford, 2016; Pickford and Senut, 1999, 2003). Recent work on the planation surfaces and more precise dating of them (Picart et al., 2020) has indicated that there are three periods of fluvial deposits along lower Orange River, at 22-18 Ma, 14-12 Ma and 4-3 Ma.

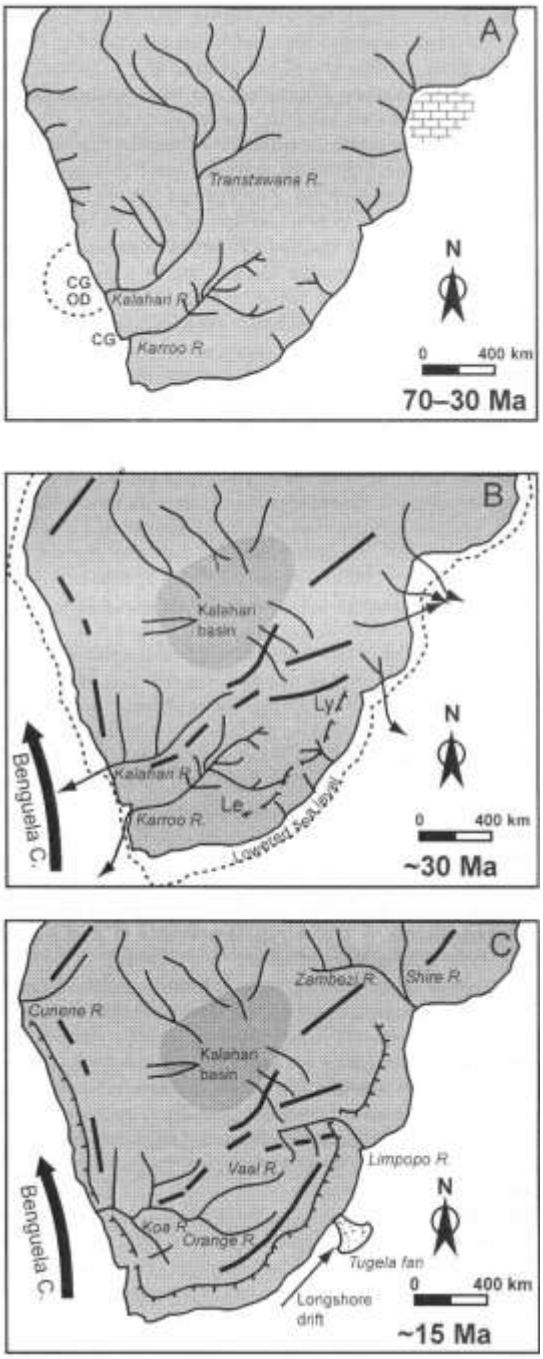

Figure 3: (From Burke and Gunnell, 2008; fig. 13) to show the palaeo-rivers of southern Africa at A – Late Cretaceous to Oligocene, 70-30 Ma; B – Oligocene, about 30 Ma; C – middle Miocene.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for the Mining Rights Application on Farm Groot Derm 10. The Gariep Supergroup rocks are volcanic in origin and do not preserve any fossils (blue on them SAHRIS map). Along the river there is a small patch of moderately sensitive rocks (green) and this applies to the Miocene and more recent gravels, sands and alluvium. These transported materials could

include alluvial diamonds and some fossils, such as fragments of silicified woods or bones that came from eroded deposits close by or very distant. Their context would be unknown. It is more likely that fossils could be preserved in abandoned river channels or oxbows, such as is the case at Arrisdrift and Daberas (Pickford and Senut, 2003) farther upstream, but these are not adjacent to the present river channel where there is active water and sediment transport.

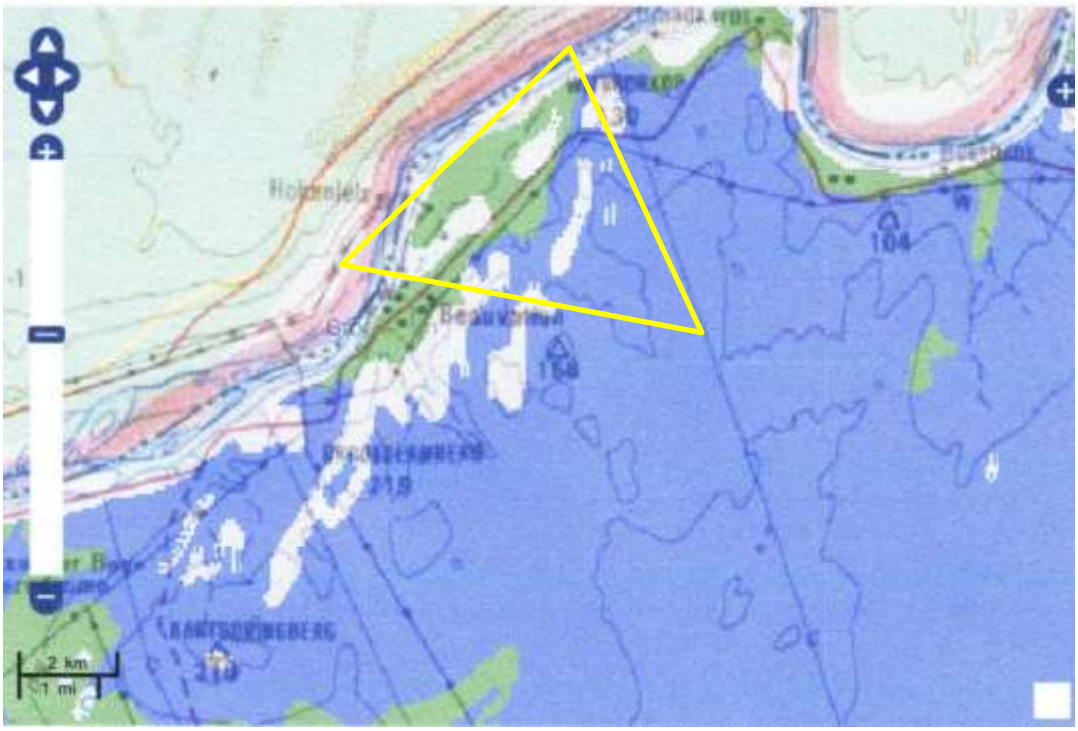

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed MR application on Groot Derm shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: 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 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	Volcanic rocks do not preserve any fossils. Alluvium and gravel might entrap transported fossils; so far there are no records from this site of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	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 transported and fragmented hard fossil bones or silicified wood from the Oligocene or Miocene in the sands and gravels, 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 sand that will be disturbed. 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 either too old and of volcanic origin to contain fossils (the Gariep Supergroup rocks), or the correct age and type but transported. Since there is an extremely small chance that fossils might have been transported along with the water and sediments along the river, and that they will be too fragmented to be identifiable, 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.

5. 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 granites, gneisses, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The gravels, sands and alluvium of the Oligocene and Miocene might have entrapped transported fossils but this a dynamic river and the removal of sediments would be frequent. Even if fossil fragments are recovered their primary context would be lost and so their value to science would be greatly reduced.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the sands, gravels and alluvium Oligocene to Miocene, or of the Quaternary. There is a very small chance that fossils may have been transported downstream and deposited alongside the river. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer or other designated responsible person once mining adjacent to the Orange River has commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Burke, K., Gunnell, Y., 2008. The African erosion surface: a continental-scale synthesis of geomorphology, tectonics, and environmental change over the past 180 million years. Geological Society of America, Memoire 201, 72pp.

de Wit, M.C.J., 1999. Post-Gondwana drainage and the development of diamond placers in Western South Africa. Economic Geology 94, 721–740.

de Wit, M.C.J., Marshall, T.R., Partridge, T.C., 2000. Fluvial Deposits and Drainage Evolution. In: Partridge, T.C. and Maud, R.R., (Eds). The Cenozoic of Southern Africa. Oxford Monographs on Geology and Geomorphology, No. 40. pp. 55-72.

Gresse, P.G., von Veh, M.W., Frimmel, H.E., 2006. Namibian (Neoproterozoic) to Early Cambrian Successions. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 395-420.

Haddon, I., McCarthy, T., 2005. The Mesozoic–Cenozoic interior sag basins of Central Africa: the Late-Cretaceous–Cenozoic Kalahari and Okavango basins. Journal of African Earth Sciences 43, 316–333.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 585-604.

Pickford, M., 2016. Cenozoic geology of the Northern Sperrgebiet, Namibia. Communications of the Geological Survey of Namibia, 10–104.

Pickford, M., Senut, B., 1999. Geology and palaeobiology of the Namib desert South-West Africa. Geological Survey of Namibia, Memoire 18, 155 pp.

Pickford, M., Senut, B., 2003. Miocène paleobiology of the Orange River Valley, Namibia. Memoire of the Geological Survey of Namibia 19, 1–22.

Picart, C., Dauteuil, O., Pickford, M., Owonoc, F.M., 2020. Cenozoic deformation of the South African plateau, Namibia: Insights from planation surfaces. Geomorphology 350 (2020) 106922.

8. 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, coal) 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 5, 6). 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.

Appendix A – Examples of fossils from the Tertiary and Quaternary.

Figure 5: Fossil bone fragments from a Quaternary fluvial deposit.

Figure 6: Fragment of silicified wood from a Pliocene deposit

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
July 2021

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.

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	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

viii) Undergraduate teaching

Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology;
Micropalaeontology – average 2-8 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 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala 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 July 2021 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 36; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)