Palaeontological Impact Assessment for the proposed Prospecting Right application for Kaalbeen, near Vioolsdrif, Northern Cape Province

Desktop Study (Phase 1)

For

ASHA Consulting (Pty) Ltd

15 April 2023

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 34 years research and lecturing in Palaeontology
26 years PIA studies and over 350 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by ASHA Consulting, Lakeside, 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 desktop Palaeontological Impact Assessment was requested for the prospecting rights application for Kaalbeen on behalf of Northern Cape Lithium and Tungsten Pty Ltd between Vioolsdrif and Springbok, Namaqualand, Northern Cape Province. Pegmatite is the target rock for a variety of minerals concentrated within it. The prospecting area is 14 976Ha and is situated on Remainder Plot 226 Vioolsdrif Settlement.

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 proposed site lies on the non-fossiliferous granites and gneisses of the Namaqualand Metamorphic Belt, indicated as having unknown to zero to insignificant palaeosensitivity on the SAHRIS map. There are smaller areas indicated as having low (blue) palaeosensitivity and this applies to the fluvial sands and alluvium along the ephemeral watercourses. It is extremely unlikely that any fossils would be found in the sands and alluvium because these are transported sediments or in the unknown areas because there is no source for fossils. Nonetheless, 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, geologist or other designated responsible person once excavations, drilling or trenching activities have commenced. Since the impact on the palaeontology is zero to low, as far as the palaeontology is concerned, the project should be authorised.

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1. Background

A draft Basic Assessment Report (DBAR) has been submitted in terms of the National Environmental Management Act, 1998 (NEMA) and the 2017 EIA Regulations for activities that trigger the Mineral and Petroleum Resources Development Act, 2002 (MPRDA)(As amended). The proposed prospecting activities will cover 14 976 Ha on the Remainder Plot 226 Vioolsdrif Settlement and will include an unknown number of drilling locations, access tracks and a temporary laydown area. The site is about 30 km south of Viooldrif and 100km north of Springbok. Prospecting will be for pegmatites as these rocks tend to concentrate a variety of rare minerals that have industrial applications. Details are provided in the Prospecting Works Programme for Northern Cape Lithium and Tungsten (Pty) Ltd document.

ASHA Consulting was appointed to provide heritage specialist input as part of the EA application in terms of section 24(4)b(iii) of NEMA and section 38(8) of the National Heritage Resources Act, Act 25 of 1999 (NHRA) that complies with section 38(3) of the NHRA.

A desktop Palaeontological Impact Assessment was requested for the Kaalbeen Prospecting 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: 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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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 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

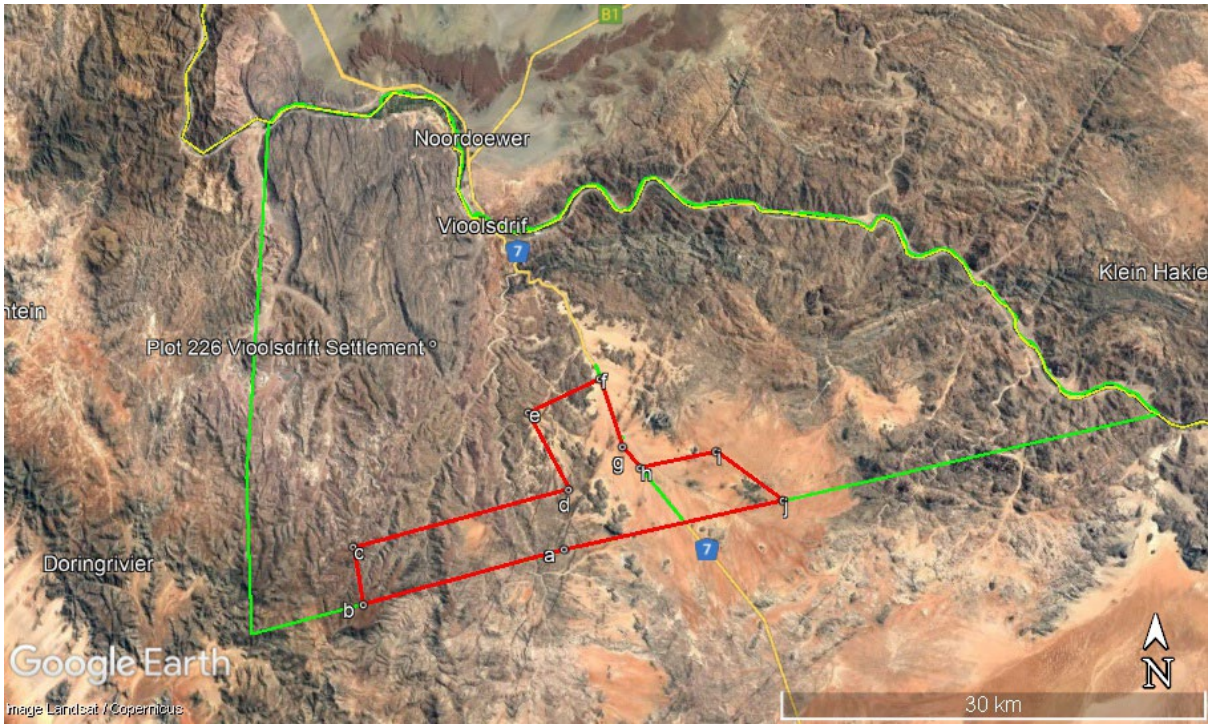

Figure 1: Google Earth map of the general area and prospecting area (red outline).

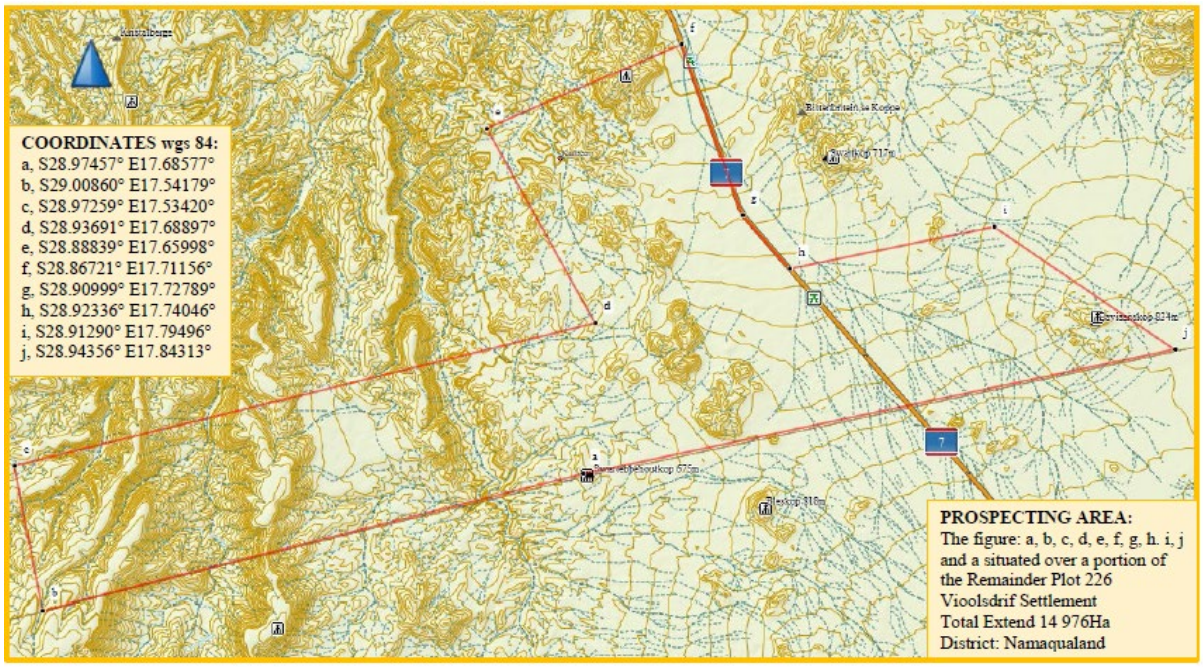

Figure 2: Simple topographic map of the proposed prospecting rights area for the Kaalbeen application shown by the red outline. Farm portions and coordinates in Table 1. Map from 03 PWP NCLT document.

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

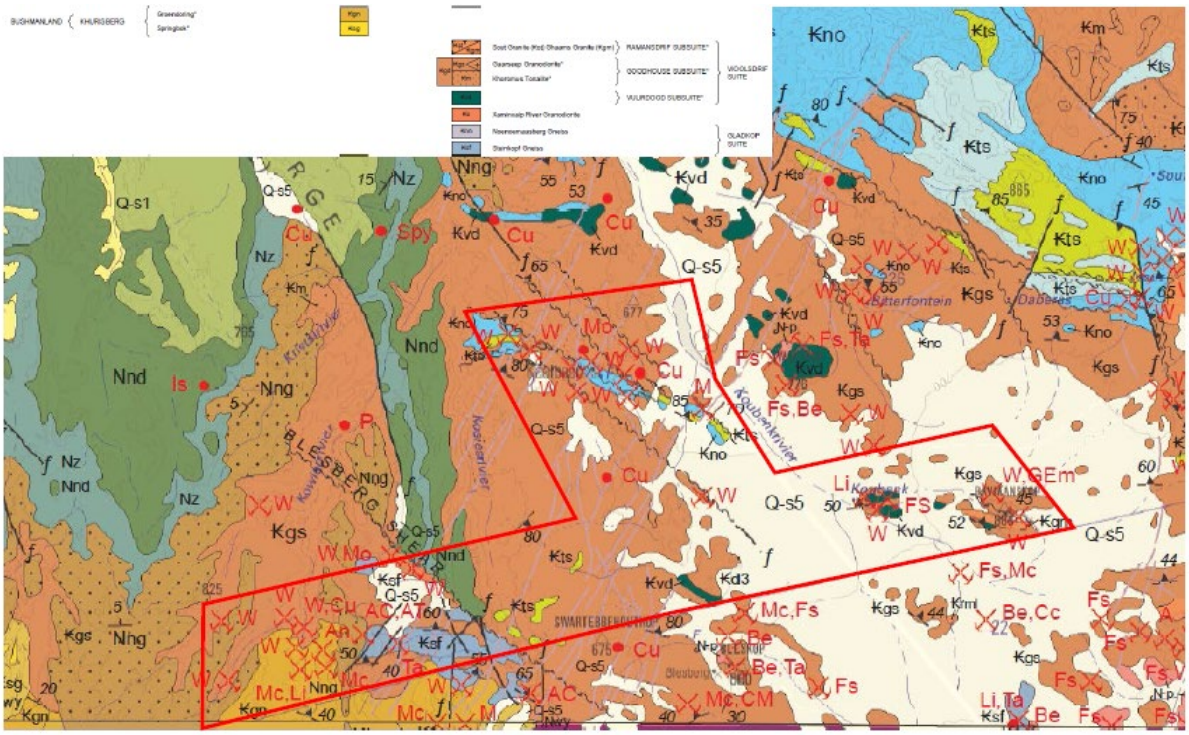

Figure 3: Geological map of the area around the Kaalbeen prospecting area with the location of the proposed project indicated within the red polygon. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2816 Alexander Bay. Notations differ in different versions of the geological maps.

Table 2: Explanation of symbols for the geological map and approximate ages (Cornell 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
Qs-1	Quaternary sand	Red wind-blown sands and dunes	Quaternary, ca 1.2 – 1 Ma
Qs-5	Quaternary sand	Sand, scree, rubble and sandy soil	Quaternary, ca 1.2 – 1 Ma
Kgn	Groendoring Fm, Khurisberg Subsuite, Bushmanland Suite	Granite	Neoproterozoic Ca 2050 – 1700 Ma
Ksg	Springbok Fm Khurisberg Subsuite, Bushmanland Suite	Granite	Neoproterozoic Ca 2050 – 1700 Ma
Kst	Sout Granite, Ramansdrif Subsuite, Vioolsrif Suite	Granite	Neoproterozoic Ca 2050 – 1700 Ma
Kgm	Ghaams Granite, Ramansdrif Subsuite, Vioolsrif Suite	Granite	Neoproterozoic Ca 2050 – 1700 Ma
Kgs/Kgd	Gaarseep Granodiorite, Goodhouse Subsuite, Vioolsdrif Suite	Granodiorite	Neoproterozoic Ca 2050 – 1700 Ma
Km/Kgd	Kkoromus Tonalite, Goodhouse Subsuite, Vioolsdrif Suite	Tonalite	Neoproterozoic Ca 2050 – 1700 Ma
Kvd	Vuurdood Subsuite, Vioolsdrif Suite		Neoproterozoic Ca 2050 – 1700 Ma
Kx	Xaminxaip Granodiorite,	Granodiorite	Neoproterozoic Ca 2050 – 1700 Ma
Knm	Noenoemaasberg Gneiss, Gladkop Suite	Gneiss	Neoproterozoic Ca 2050 – 1700 Ma
Ksf	Steinkopf Gneiss, Gladkop Suite	Grey fine-grained gneiss	Neoproterozoic Ca 2050 – 1700 Ma

The prospecting rights area on the Remainder Plot 226 Vioolsdrif Settlement lies in the Namaqua-Natal Province in the Namaqua section (Figure 3, Table 2). The Namaqua-Natal Province is a tectono-stratigraphic province and forms the southern and western boundary of the ancient Kaapvaal Craton, and extends below the Karoo Basin sediments to the south (Cornell et al., 2006). It comprises rocks that were formed during the Namaqua Orogeny (mountain-building) some 1200 – 1000 million years ago. It has been divided by geologists into a number of terranes (similar lithology and bounded by shear zones). There are three main lithologic units used to separate the terranes as well as the shear zones but still there is some debate about the terranes (ibid). Very simply, the lithologic units are older reworked rocks, juvenile rocks formed during tectonic activities and metamorphosed, and intrusive granitoids.

According to Cornell et al. (2006) the five terranes are:
A - Richtersveld Subprovince (undifferentiated terranes)
B – Bushmanland Terrane (granites)
C – Kakamas Terrane (supracrustal metapelite ca 2000 Ma
D – Areachap Terrane (supracrustal rocks and granitoids)
E – Kaaien Terrane (Keisian aged metaquartzites and deformed volcanic rocks).

The project lies in the Bushmanland Terrane with its northern boundary against the Richtersveld Subprovince and the eastern boundary against the Kakamas Terrane (ibid). The Namaqua-Natal Province rocks are volcanic in origin and frequently metamorphosed. Several outcrops occur in the area and probably underlie the fluvial alluvium and Gordonia sands. Several periods of intrusion have occurred and these are from older to younger: the Gladkop Suite, the Vioolsdrif Suite, and the Bushmanland Suite.

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).

The beds of the ephemeral watercourses are sandy and gravelly and have been derived from weathered and loose material upstream so the source rocks will be the granites, quartzites and gneisses of the Namaqua Suite.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for prospecting is mainly in the non-fossiliferous igneous and metamorphic rocks of the Namaqua Suite, in particular the Gladkop, Vioolsdrif and Bushmanland Suites. Such rocks do not preserve fossils and their weathered products would not contain any fossils either. Some of these areas are shown as white or clear on the map indicating unknown palaeosensitivity, however, there is no source for transported rocks, and volcanic rocks do not preserve fossils.

Quaternary sands and alluvium are in the riverbeds and ephemeral watercourses, possibly sourced from the Gordonia Formation. Since these sands have been transported they would not contain any fossils in primary context. They might have included fragments of more robust fossils such as bones or silicified woods from farther upstream. When and if the rivers flow the stones, bones and fragments would be tumbled and washed downstream so their occurrence would be very rare and unpredictable. Sands themselves do not preserve fossils because they are friable and coarse-grained. The preservation of fossils requires the burial of organic matter in a low energy, fine-grained sediment that excludes oxygen and therefore reduces the degradation of organic matter (Briggs and McMahon, 2016). The SAHRIS palaeosensitivity map indicates that the area is of low to zero sensitivity (Figure 4) which is correct because the upstream or source rocks do not preserve fossils either.

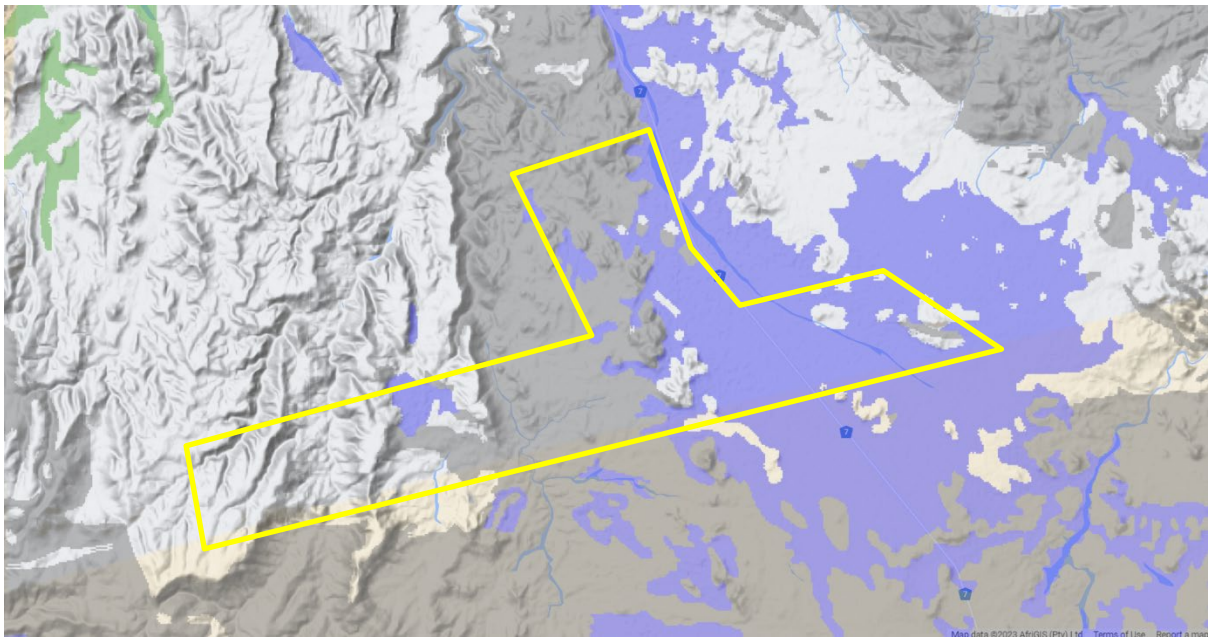

Figure 4: SAHRIS palaeosensitivity map for the site for the prospecting rights application for Kaalbeen, shown within the yellow polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero; white = unknown.

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.
	L	Quickly reversible. Less than the project life. Short term

Criteria for ranking the DURATION of impacts	**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	Granites, gneiss, aeolian and alluvial sands do not preserve fossils; so far there are no published records 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 transported, robust fossils in the sands of the river beds, 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 or in the granites and gneisses. 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 much too old and of the incorrect type to contain fossils (Suite, Gladkop, Vioolsdrif and Bushmanland Suites) or are transported sands derived from a non-fossiliferous source. Since there is an extremely small chance that transported fossils may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the significance of potential impacts 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, gneiss, quartzites, sandstones and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils because the material is transported and friable.

6. Recommendation

Based on the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the sands and alluvium of the Quaternary. There is a very small chance that fossils may occur in river beds so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the contractor, geologist or other responsible person once drilling 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 extremely low so the project should be authorised.

7. References

Briggs, D.E.G., McMahon, S., 2016. The role of experiments in the taphonomy of exceptional preservation. Palaeontology 59, 1-11.

Cornell, D.H., Thomas, R.J., Moen, H.F.G., Reid, D.L., Moore, J.M., Gibson, R.L., 2006. The Namaqua-Natal Province. 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 325-379.

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.

Roberts, D.L., Botha, G.A., Maud, R.R., Pether, J., 2006. Coastal Cenozoic deposits. 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 605-628.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/trenching commence.
2. When excavations begin the rocks and sand must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, trace fossils) 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 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 or contractor 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.

9. Appendix A – Examples of fossils from the Quaternary

Figure 5: Photographs of fossils that have been recovered from other parts of South Africa from Quaternary rivers, pans and abandoned channels. Note the fragmentary nature of these robust fossils.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2023

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	13	3
PhD	13	6
Postdoctoral fellows	15	4

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 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 2023 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 31; Google scholar h-index = 39; -i10-index = 116.
Conferences: numerous presentations at local and international conferences.