Palaeontological Impact Assessment for the proposed clearing for agriculture on farm River 141 MS, west of Musina, Vhembe District, Limpopo Province

Desktop Study (Phase 1)

For

Tua Conserva Environmental & Conservation Services cc

19 September 2021

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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 Tua Conserva Environmental & Conservation Services cc, 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 clearing of indigenous vegetation for the planting of new lands for citrus and crops on the Remaining Extent of farm River 141 MS, about 27 km west of Musina, and along the Limpopo River, Limpopo 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 proposed site lies on the non-fossiliferous gneiss of the Malala Drift Group (Beit Bridge Complex, Limpopo Belt) and on the sands and alluvium of the Quaternary Kalahari Group that has moderate palaeosensitivity according to the SAHRIS Palaeosensitivity map. Since there are no palaeo-pans or palaeo-springs in the vicinity it is very unlikely that fossils would occur in the project footprint. Nonetheless, a Fossil Chance Find Protocol should be added to the management plan. Based on this information it is recommended that no further palaeontological assessment is required unless fossils are found by the environmental officer or responsible person once vegetation clearing and ploughing commence. It is recommended that as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

The proposed development is situated on Remaining Extent of the farm River 141 MS, ±27 kilometers west from Musina Local Municipality, located on the Limpopo River. The farm is accessed via Beitbridge and the military patrol road along the river, in Vhembe District in the Limpopo Province. The area is primarily managed for game and crop farming. Landuse zoning is for agriculture.

The co-ordinates (WGS84) of the proposed sites are approximate:
• Latitude 22° 12’ 26.57” and Longitude 29° 51’ 37.73” (Figures 1, 2).

The project, known as the River South Development, is for the clearing of indigenous vegetation for new lands for citrus and crops. A preliminary footprint area of 100 hectares was identified adjoining onto the existing croplands. The footprint area will only be defined and made available after the input of the necessary specialist reports

The physical environment on the farm consists of existing croplands and natural vegetation. According to Mucina & Rutherford (2006), the study area is situated in the Central Bushveld Bioregion with Limpopo Ridge Bushveld (SVmp2) and Musina Mopane Bushveld (SV mp1) vegetation. The project area is located ±2.3 kilometres south of the Limpopo River adjoining onto the existing crop farming.

A Palaeontological Impact Assessment was requested for the agriculture project on farm River 141 MS. 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 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
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

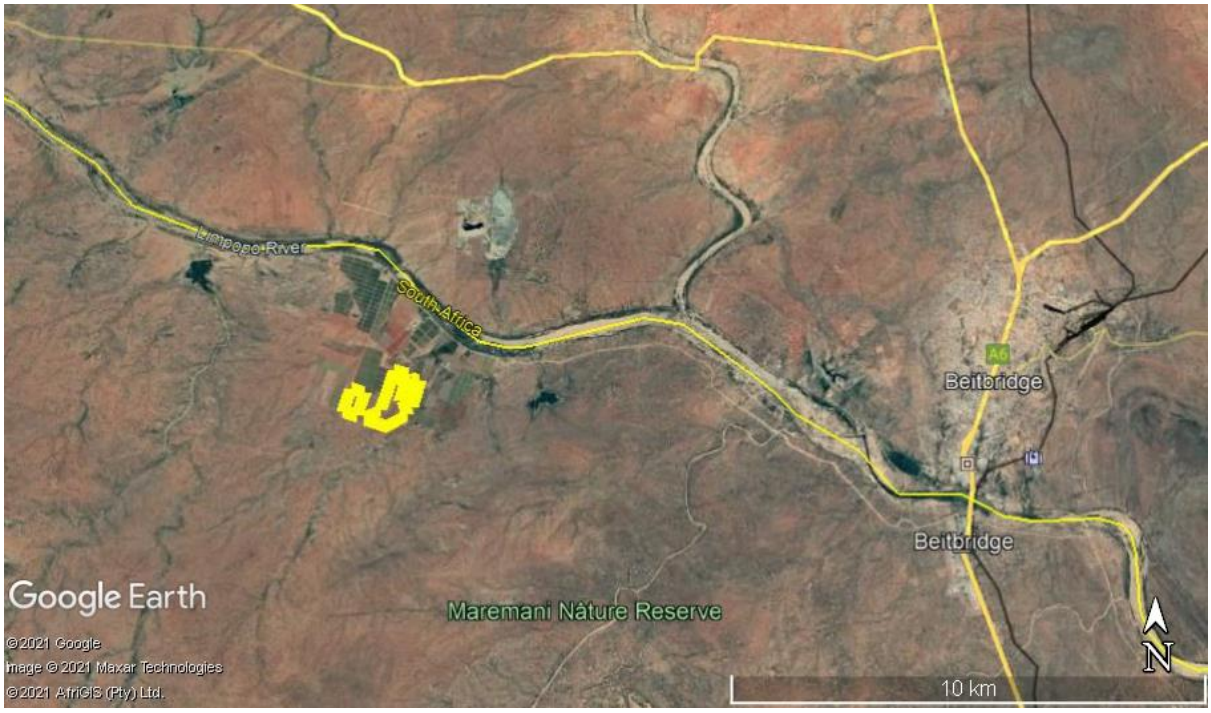

Figure 1: Google Earth map to show the project site in relation to the nearest landmark, Beitbridge.

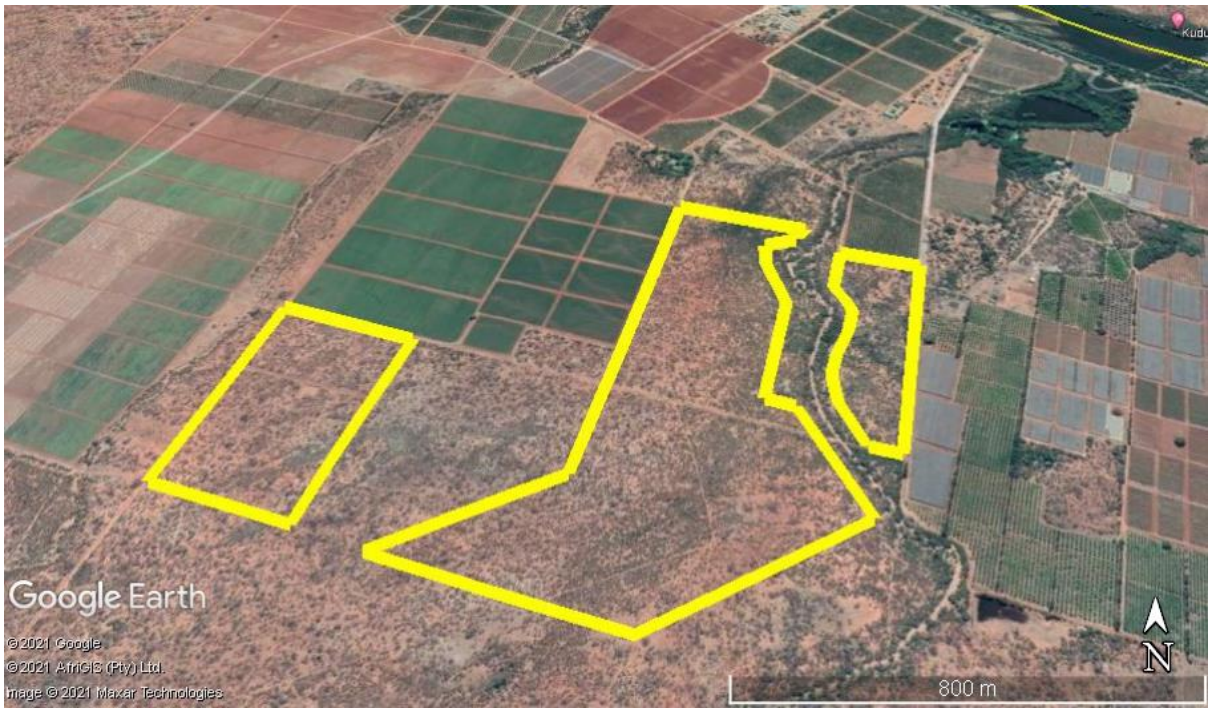

Figure 2: Google Earth map of the proposed development for agriculture on the remaining extent of farm River 141 MS with the sections shown by the yellow polygons. Map supplied by Tua Conserva.

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

The farm River 141 MS is the north of South Africa and geologically in the Limpopo Belt (Kramers et al., 2006), a zone of gneisses between the two granitoid-greenstone terranes, the Zimbabwe and Kaapvaal Cratons (Figure 3). The Limpopo Belt can be divided into three domains, namely the Central Zone, the Southern Marginal Zone and the Northern Marginal Zone (Mason, 1973). In the Central Zone is the Beitbridge Complex, including the Malala Drift Group gneiss that is about 2600 million years old (Kramers et al., 2006). The Limpopo Belt is structurally complex and had undergone high grade metamorphism and intrusions so it is difficult to correlate the rocks within this region (ibid).

Much of the Limpopo Belt has been covered by younger rocks (Kramers et al., 2006). The boundary between the Southern Marginal Zone and the Central Zone is covered by the Proterozoic Soutpansberg Trough (2000 – 1900 Ma). The boundary between the Northern Marginal Zone and the Central Zone is covered by the Tuli Trough (Karoo age). Quaternary sands, soils and alluvium also cover much of all these rocks.

The Quaternary Kalahari sands form an extensive cover of much younger deposits over much of the Northern Cape Province and Botswana. 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. Mantle plumes caused uplift of the continent during the late Cretaceous, followed by erosion and further uplift about 30-20 million years ago (Burke 2011). 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.

There are numerous pans in the Kalahari, generally 3–4 km in diameter (Haddon and McCarthy, 2005). According to Goudie and Wells (1995) there are two conditions required for the formation of pans. Firstly, the fluvial processes must not be integrated, and second, there must be no accumulation of aeolian material that would fill the irregularities or depressions in the land surface. Favoured materials or substrates for the formation of pans in South Africa are Dwyka and Ecca shales and sandstones (ibid). Relatively few pans, however, occur in northern Limpopo.

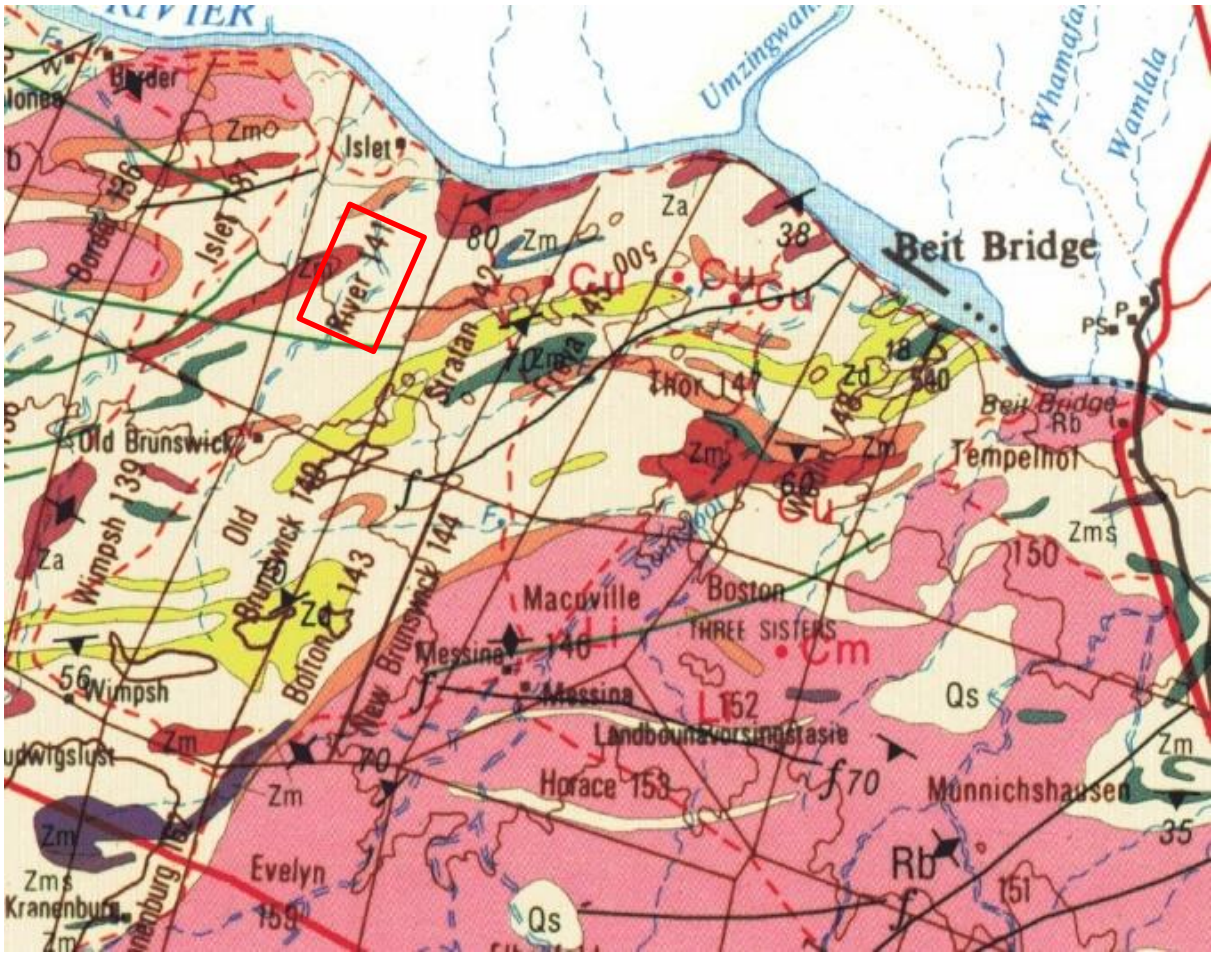

Figure 3: Geological map of the area around Farm River 141 MS with the location of the proposed project indicated within the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2228 Alldays.

Table 2: Explanation of symbols for the geological map and approximate ages (Kramers 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, sand, calcrete	Neogene, ca 2.5 Ma to present
Zgu	Gumbu Group, Beit Bridge Complex, Central Zone, Limpopo Belt	Marble, calc-silicate rocks	Ca 2750 – 2600 Ma
Zm	Malala Drift Group, Beit Bridge Complex, Central Zone, Limpopo Belt	Leucocratic gneiss, mainly garnetiferous; dotted = with amphibolite and mafic granulite	Ca 2750 – 2600 Ma
Zd	Mt Dowe Group, Beit Bridge Complex, Central Zone, Limpopo Belt	Meta-quartzite, magnetic quartzite	Ca 2700
Zms	Messina Suite, Beit Bridge Complex, Central Zone, Limpopo Belt	Meta-pyroxenite, serpenitinte	Ca 3200 - 3100

ii. Palaeontological context

The metamorphosed rocks of the Beit Bridge Complex do not preserve fossils. Moreover, they predate the evolution of any body fossils and only microorganisms were around at that time.

While fossils are not preserved in young sands, the sand might entrap fossils that have been transported by wind or water, These would be very small or fragmented. Associated with Quaternary sands and sand dunes are palaeo-pans and palaeo-springs that could trap or preserve fossils if there was water and calcium to preserve the material. For example, some palaeo-pans and palaeo-springs could contain fossil bones, root casts, pollen and archaeological artefacts. Well-known sites are Florisbad and Deelpan in the Free State, Wonderkrater in Limpopo and Bosluispan in the Northern Cape.

There are no records of pans in this area and the satellite imagery does not indicate any pans on the proposed site.

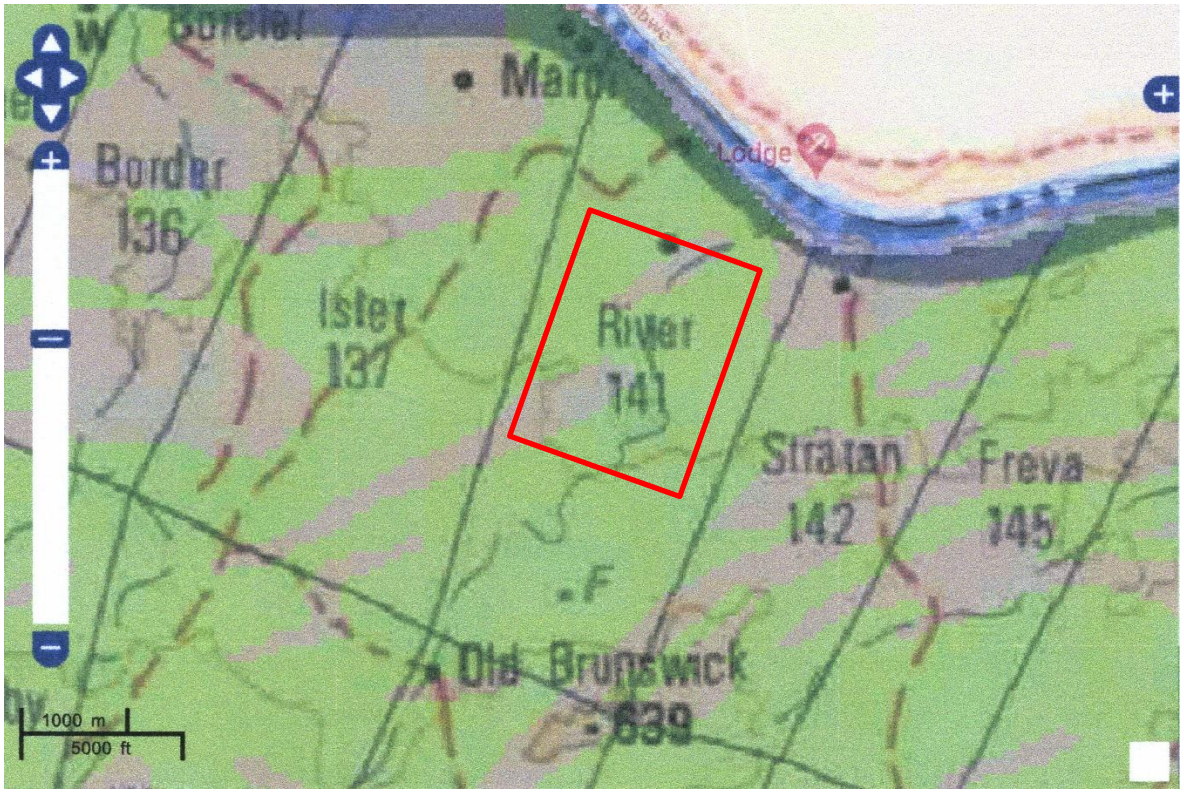

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed agriculture project on Farm River 141 MS shown within the red rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 4), the area is indicated as moderately sensitive (green) for the Quaternary Kalahari sands and as having low sensitivity for the metamorphic rocks of the Malala Drift Group.

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	Metamorphosed igneous rocks do not preserve any fossils; so far there are no records from the Quaternary 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 fossil fragments or palaeo-pan associated fossils of Quaternary age, 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 sands and soils that will be excavated. 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 the wrong type to contain fossils (Malala Drift gneiss) or the correct age but not likely to preserve fossils (Quaternary sands). Since there is an extremely small chance that fossils from palaeo-pans or palaeo-springs may be disturbed 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 dolomites, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. No fossils have been recorded from the region and from the satellite imagery there do not appear to be features that might trap fossils, such as palaeo-pans or palaeo-springs in the development footprint. It is not known what is buried underneath the sands.

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, soils and alluvium of the Quaternary. There is a very small chance that fossils may occur in palaeo-pans or palaeo-springs but there is none in the project footprint. Nonetheless, the area is indicated as moderately sensitive in the SAHRIS palaeosensitivity map so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the Environmental officer or contractor once clearing of vegetation, ploughing and planting has commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Burke, K., 2011. Plate Tectonics, the Wilson Cycle, and Mantle Plumes: Geodynamics from the Top. Annual Review of Earth and Planetary Sciences 39, 1–29.

Goudie, A.S., Wells, G.L., 1995. The nature, distribution and formation of pans in arid zones. Earth Science Reviews 38, 1–69.

Haddon. I.G., McCarthy, T.S., 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.

Kramers, J.D., McCourt, S., van Reenen, D.D., 2006. The Limpopo Belt. 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 209-236.

Lancaster, I.N., 1978a. The pans of the southern Kalahari, Botswana. Geographical Journal 144, 80–98.

Lancaster, I.N., 1978b. Composition and formation of southern Kalahari pan margin dunes. Zeitschrift fur Geomorphologie 22, 148–169.

Lancaster, N., 1986. Pans in the southwestern Kalahari: a preliminary report. Palaeoecology of Africa 17, 59–67.

Mason, R. 1973. The Limpopo Mobile Belt – southern Africa. Philosophical Transactions of the Royal society of London A273, 463-485.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the clearing, ploughing and planting activities begin.

1. The following procedure is only required if fossils are seen on the surface and when clearing and ploughing activities 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) 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 management 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 then a 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 Quaternary Kalahari sands

Figure 5: Fragments of bones from a fluvial deposit

Figure 6: Fragments of silicified wood from a Quaternary fluvial deposit. Scale = 12 cm.

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 = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.