Palaeontological Impact Assessment for the Prospecting Right with bulk sampling over various farms in the Hay and Kuruman Administrative Districts, Northern Cape Province

Desktop Study (Phase 1)

For

Beyond Heritage (Pty) Ltd
And
Greenmined Environmental (Pty) Ltd

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Expertise of Specialist

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Experience: 35 years research and lecturing in Palaeontology
27 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 Beyond Heritage (Pty) Ltd, Modimolle, 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: *MKBamford*

Executive Summary

A Palaeontological Impact Assessment was requested for the prospecting right with bulk sampling on several farms in the Hay and Kuruman Administrative District, Northern Cape Province. Prospecting will be for diatomite (or Kieselguhr or diatomaceous earth). The six land parcels are:

1- Portion 1 and the Remaining Extent of the farm Botha No 313 and Portion 1 and the Remaining Extent of the farm Devon No 277.
2- Portions 4 and 5 of the farm Bermolli No 583.
3- Portion 1 and the Remaining Extent of the farm Engelsdraai No 221.
4- Portion 1 and the Remaining Extent of the farm Witdraai No 204.
5. Portions 1 and 2 and the Remaining Extent of the farm Vaalwater No 84.
6. Farm No 570.

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 sites lie on the sands and aeolian sands of the Quaternary Kalahari Group that might cover and obscure fossil traps such as palaeo-pans or palaeo-springs. No such feature, however, is visible in the satellite imagery. It should be noted that diatomite is a deposit of ancient diatoms which are the silica skeletons of algae so it is a high concentration of fossils. Therefore, **it is strongly recommended that a sample of diatomite must be deposited in a recognised institution (McGregor Museum in Kimberley or a palaeontological research institute), and SAHRA notified, so that the palaeontological heritage is not lost completely.** In addition, a Fossil Chance Find Protocol for non-diatomite fossils 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 drilling activities have commenced. Since the impact will be very low, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

The Applicant, K2022641005 (SOUTH AFRICA) (Pty) Ltd has applied for a prospecting right with bulk sampling on several farms in the Hay and Kuruman Administrative Districts, Northern Cape Province. Prospecting will be for diatomite (or Kieselguhr or diatomaceous earth). The proposed project triggers listed activities in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) and the Environmental Impact Assessment Regulations 2014 (as amended) and therefore requires an environmental impact assessment that assess project specific environmental impacts and alternatives, consider public input, and propose mitigation measures, to ultimately culminate in an environmental management programme that informs the competent authority (Department of Mineral Resources and Energy) when considering the environmental authorisation.

The six land parcels are:

1- Portion 1 and the Remaining Extent of the farm Botha No 313 and Portion 1 and the Remaining Extent of the farm Devon No 277 (Kuruman Magisterial District; total area 3665.95 ha) (Figures 1-2).

2- Portions 4 and 5 of the farm Bermolli No 583 (Hay Magisterial District; total area 3301.13 ha) (Figures 1, 3).
3- Portion 1 and the Remaining Extent of the farm Engelsdraai No 221 (Hay Magisterial District; total area 2732.3 ha) (Figures 1, 3).

4- Portion 1 and the Remaining Extent of the farm Witdraai No 204. (Hay Magisterial District; total area 2781.9 ha) (Figures 1, 4).
5- Portions 1 and 2 and the Remaining Extent of the farm Vaalwater No 84 (Hay Magisterial District; total area 3121.8 ha) (Figures 1, 4).
6- Farm No 570 (Hay Magisterial District; total area 575.3 ha (Figure 1,4).

A Palaeontological Impact Assessment was requested for the FSR Northern Cape prospecting right application (PRA) 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
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	Section 8
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

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

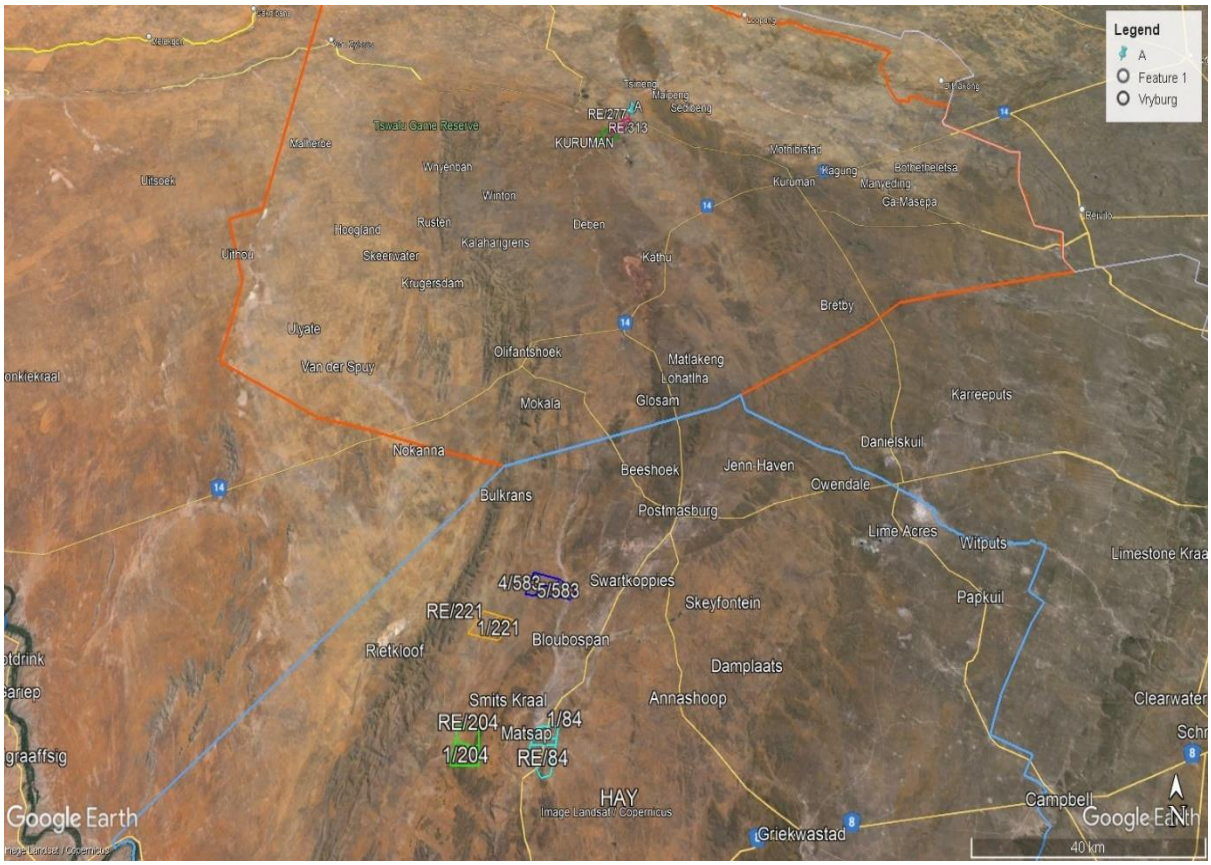

Figure 1: Locality map for the FSR PRA in the Kuruman Magisterial district (orange outline; one site – north area) and the Hay District (blue outline; four sites – south area).

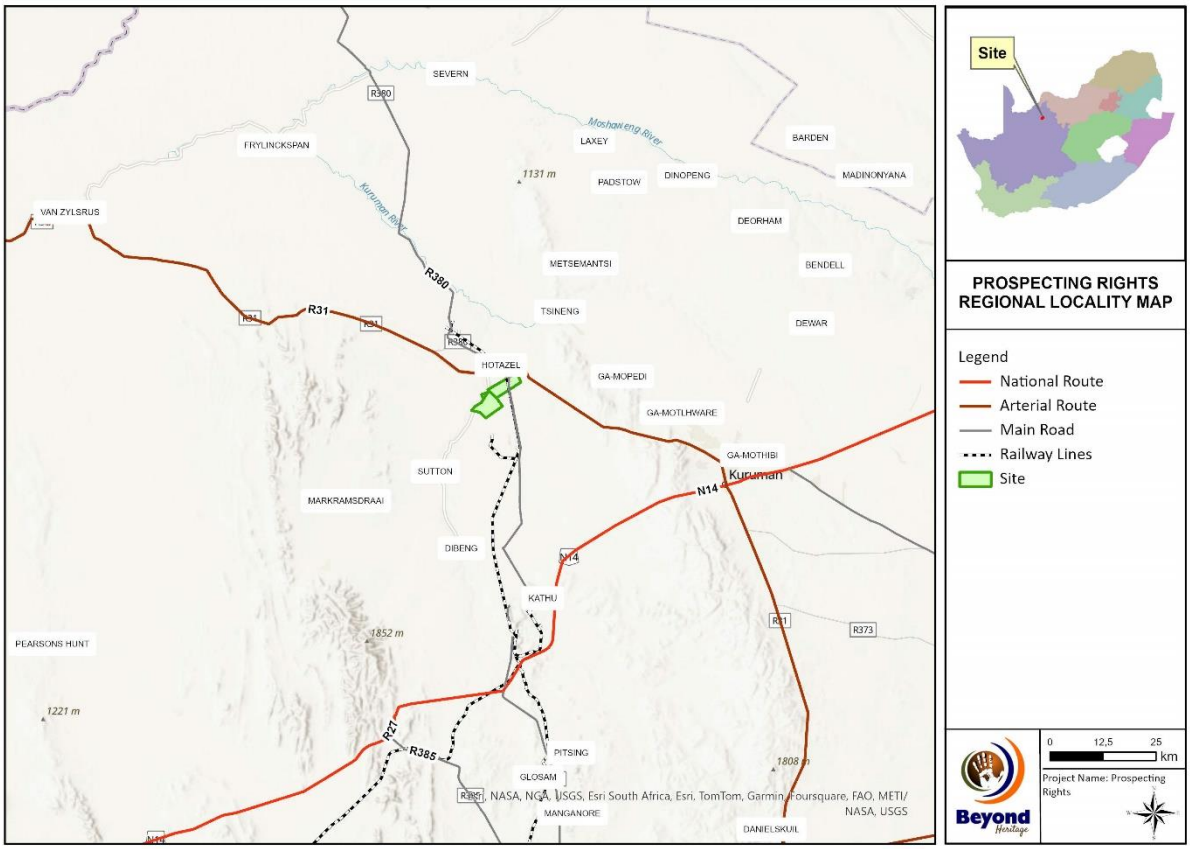

Figure 3: Regional locality map for the northern area. Map supplied by Beyond Heritage

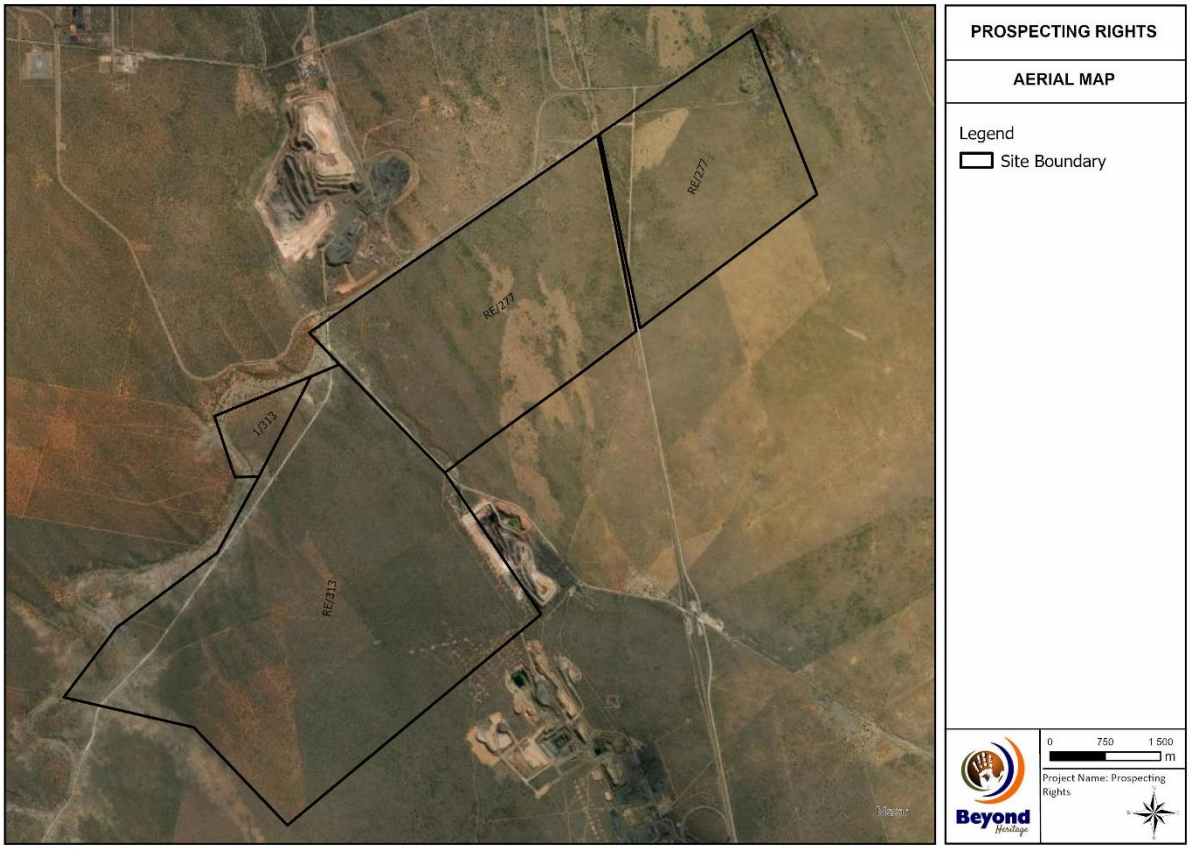

Figure 3: Aerial map of the north area: Botha 313 and Devon 277 prospecting areas shown by the green and pink polygons, respectively, in the Kuruman District.

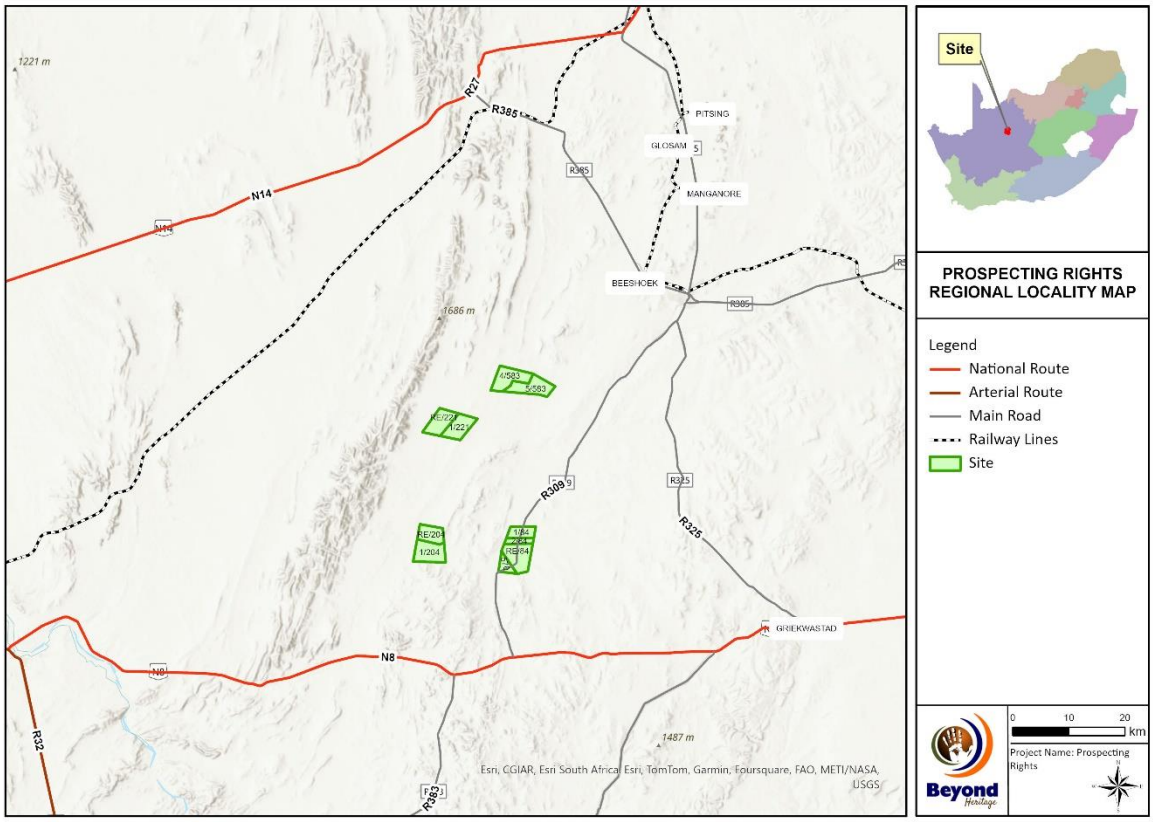

Figure 4: Regional locality map for the southern area.

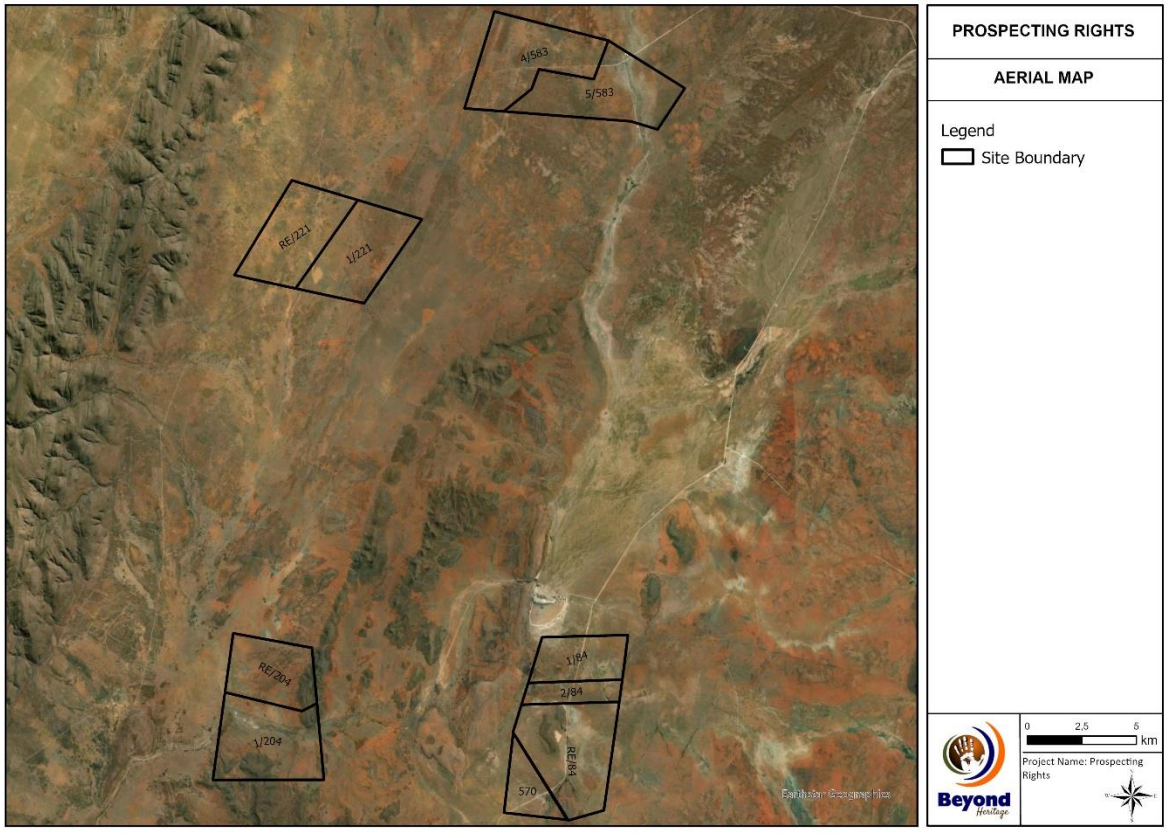

Figure 5: Aerial map of the southern area: Bermolli 583, Engeldraai 221, Witdraai 204, Vaalwater 84 and Farm 570 (black polygons).

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 include 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

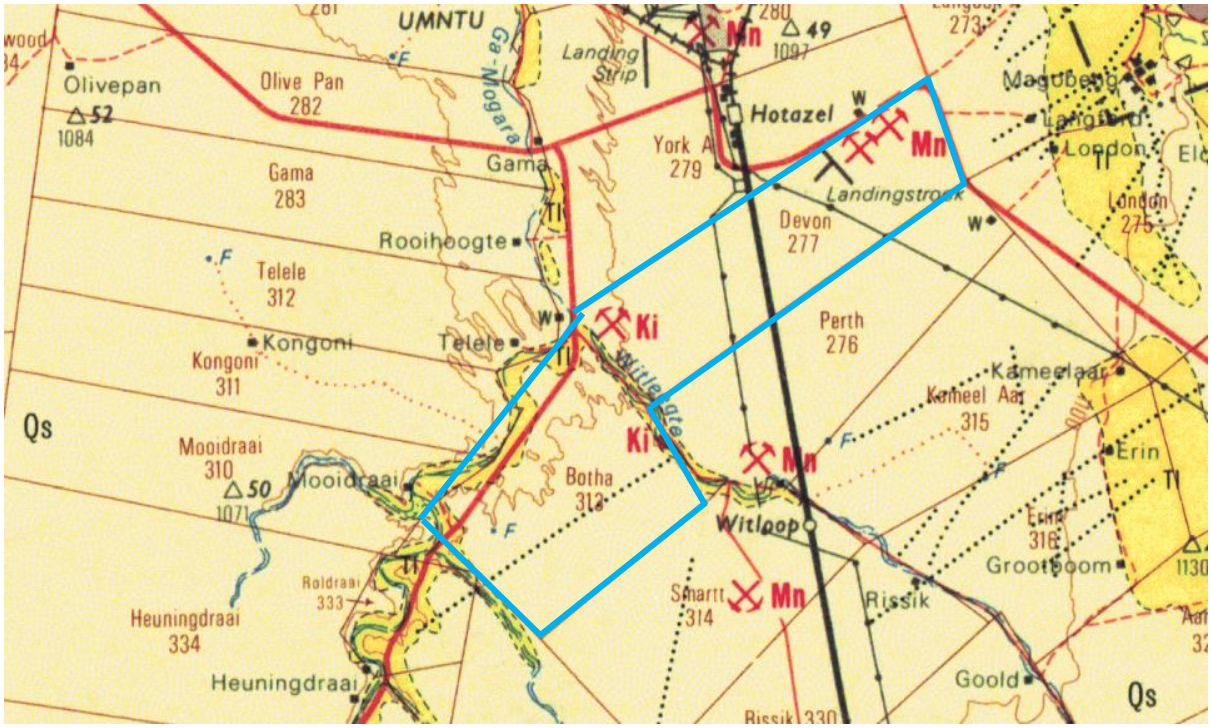

Figure 6: Geological map of the area around the Farms Botha 313 and Devon 277 (Kuruman District) shown within the blue outlines. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2722 Kuruman.

Table 2: Explanation of symbols for the geological maps and approximate ages (Eriksson et al., 2006; Schier et al., 2018;). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary	Alluvium, sand, calcrete	Quaternary, ca 1.0 Ma to present
Tl	Tertiary limestone	limestone	Tertiary
Vo	Ongeluk Fm, Postmasburg Group, Griqualand West Sequence of the Transvaal SG	Andesitic lavas	Palaeoproterozoic Ca 2426 Ma
Vkk	Kwakwas Fm, Griqualand West Sequence of the Transvaal SG	Brown jaspilite, banded iron, quartzite, dolomite	Palaeoproterozoic Ca 2430
Vad	Danielskuil Fm, Asbestos Hills Subgroup/ Manganore Iron Formation, Ghaap Group, Transvaal SG	Brown jaspilite and crocidolite, (Banded iron formation and manganese formation)	Palaeoproterozoic Ca 2440
Vak	Kuruman Fm, Asbestos Hills Subgroup/ Manganore Iron Formation, Ghaap Group, Transvaal SG	Banded iron formation with bands of amphibolite; conglomerate layers	Palaeoproterozoic Ca 2460 Ma

Figure 7: Geological map of the area around the Farms Bermolli 583 and Engeldraai 221 (Hay District) shown within the black outlines. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2822 Postmasburg.

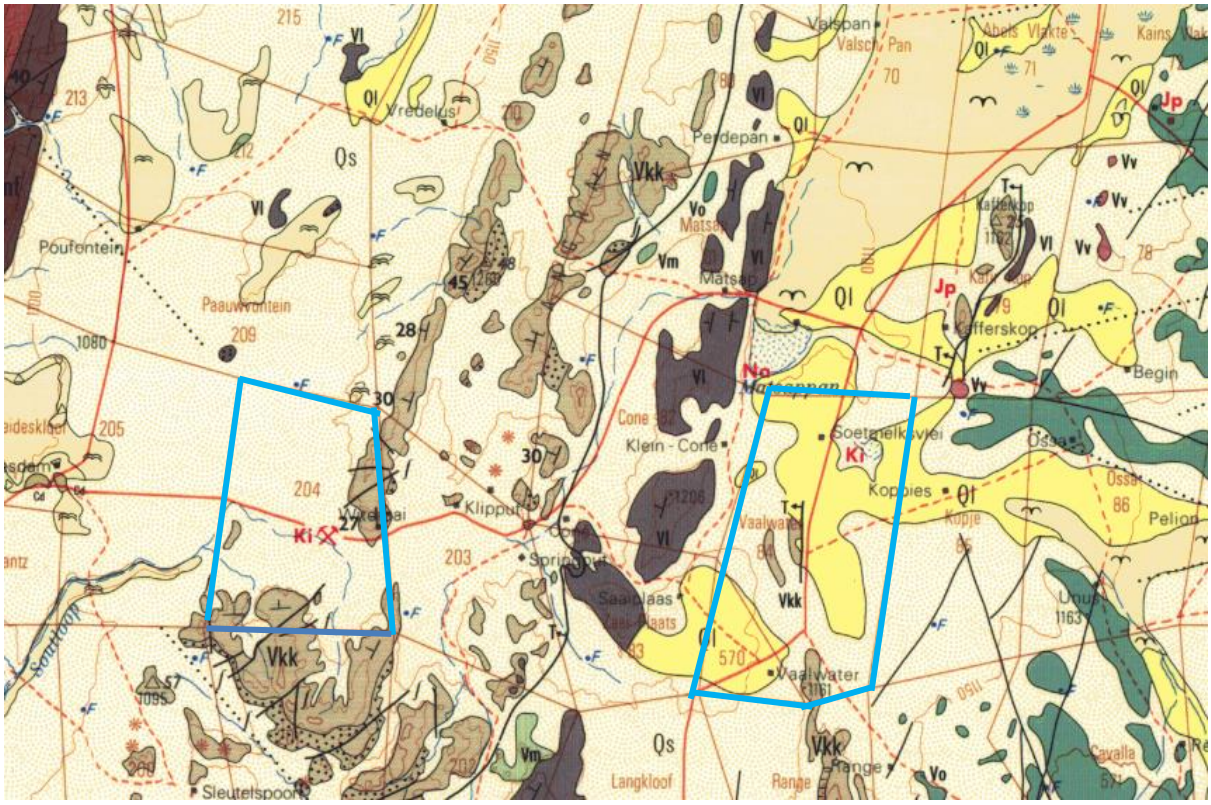

Figure 8: Geological map of the area around the Farms Witdraai 204,Vaalwater 84 and Farm 570 (Hay District) shown within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2822 Postmasburg.

The project lies in the Griqualand West Basin of the Transvaal Supergroup with much younger sands and alluvium of the Kalahari Group overlying much of the area (Figures 6-8).

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.

The Transvaal Supergroup rocks in the Griqualand West Basin can be correlated with the rocks in the Transvaal Basin, closely according to Beukes and colleagues, or not so closely according to Moore and colleagues. Nonetheless, these rocks represent on a very large scale, a sequence of sediments filling the basins under conditions of lacustrine, fluvial,

volcanic and glacial cycles in a tectonically active region. The predominantly carbonaceous sediments are evidence of the increase in the atmosphere of oxygen produced by algal colony photosynthesis, the so-called Great Oxygen Event (ca 2.40 – 2.32 Ga) and precursor to an environment where diverse life forms could evolve. The Neoarchean-Paleoproterozoic Transvaal Supergroup in South Africa contains the well-preserved stromatolitic Campbellrand -Malmani carbonate platform (Griqualand West Basin – Transvaal Basin respectively), which was deposited in shallow seawater shortly before the Great Oxidation Event (GOE).

There were two large basins dominating southern Africa during the Cenozoic, with the Kalahari Basin to the west and the Bushveld basin to the east. Both basins are bounded along their southern extent by the more or less west-east trending Griqualand-Transvaal Axis (Partridge et al., 2006). These sediments are not easy to date but recent attempts are gradually filling in the history of the sands, sand dunes and inter-dunes (Botha, 2021).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Most geological maps indicate these sands simply descriptively (aeolian sand, gravelly sand, calcrete) or they are lumped together as the Gordonia Formation because the detailed regional lithostratigraphic work has not been done, Nonetheless, these sands have eroded from the interior and have been transported by wind or water to fill the basin. Reworking of the sands or stabilisation by vegetation has occurred. Probable ages of dune formation are around 100 kya (thousand years), 60 kya, 27-23 kya and 17-10 kya (in Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 9-11. The sites for prospecting mostly are covered by Kalahari Group sands (moderately sensitive; green) with some patches of Tertiary limestone that is highly sensitive (orange).

Quaternary aeolian sands and alluvium are fairly mobile and very porous so they do not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, is there any chance of fossilisation. For example, roots can be encased in calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, and can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

The target rocks for prospecting are diatomite (also known as Kieselguhr or diatomaceous earth). This rock-type has been completely ignored by SAHRA and the authors of the provincial palaeotechnical reports (Groenewald et al., 2014). Mapping of the outcrops is incomplete (Botha, 2021) but it should be indicated as very highly sensitive.

Diatomite is the accumulation of millions of diatoms which are microscopic algae of the Chrysophyta that have silica exoskeletons (see Appendix A for photographs). Seasonal or pH changes trigger the mass death of the floating algae and their exoskeletons are deposited at the bottom of lakes.

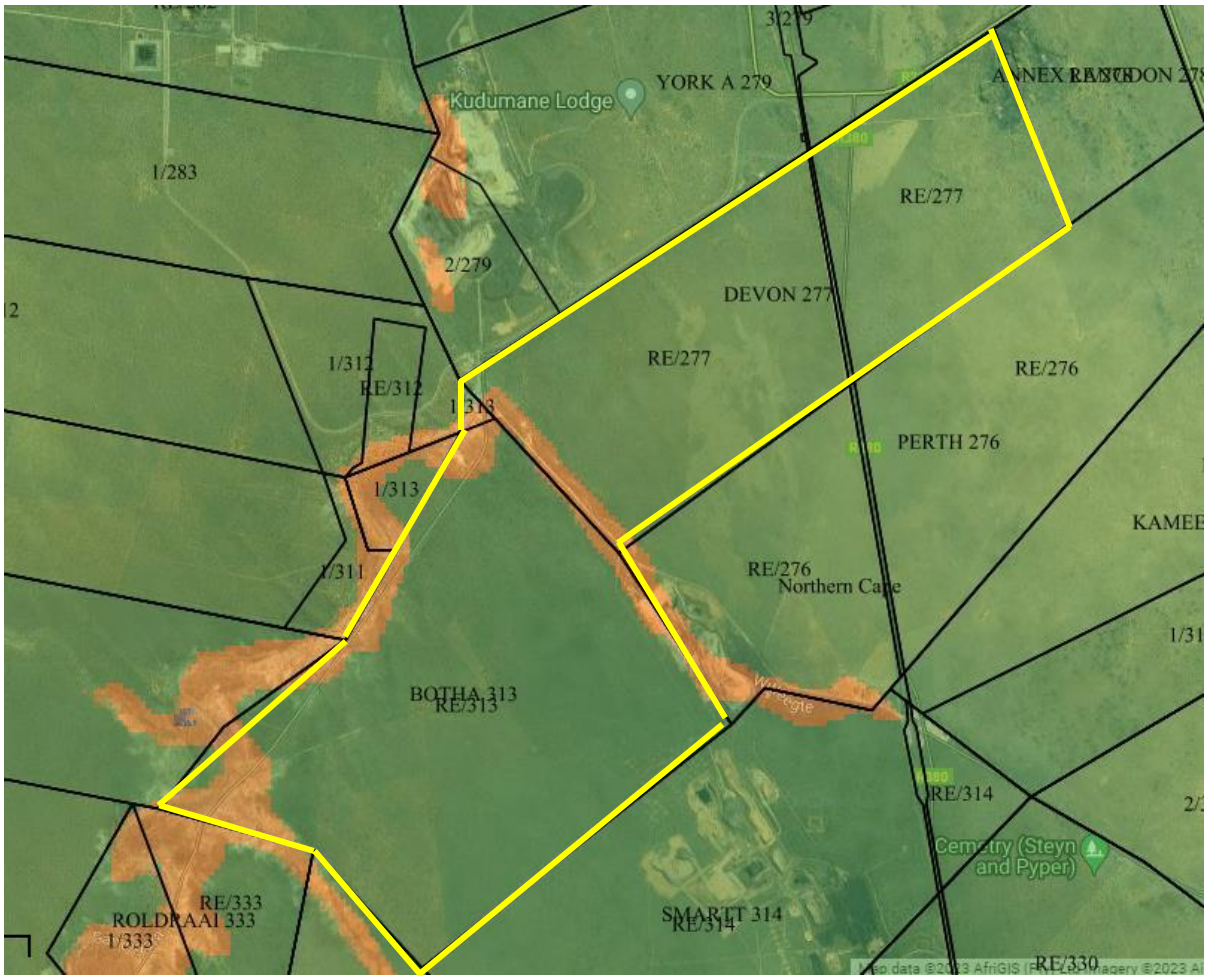

Figure 9: SAHRIS palaeosensitivity map for the site for the Botha 313 and Devon 277 PRA shown within the yellow polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

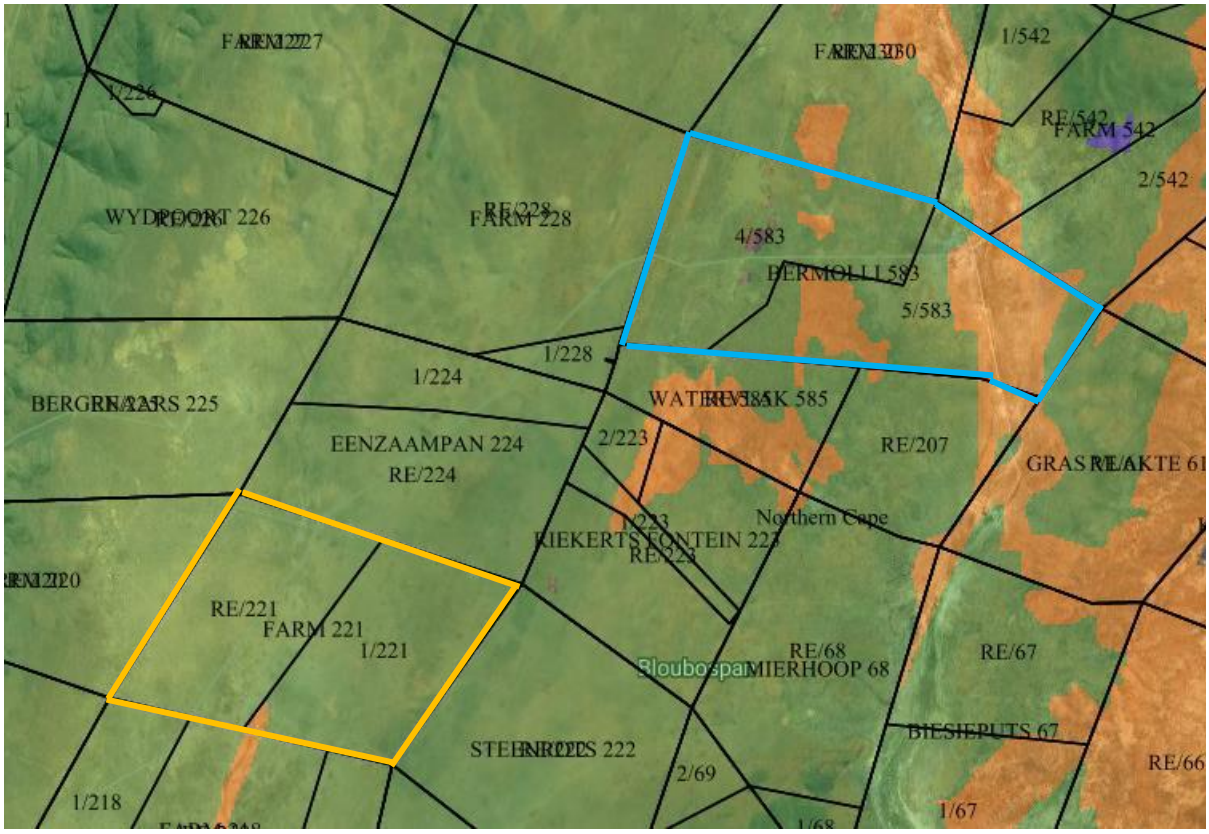

Figure 10: SAHRIS palaeosensitivity map for the farms Bermolli No 583 (blue polygon) and Engelsdraai No 221 (orange polygon). Colour coding same as in Figure 13.

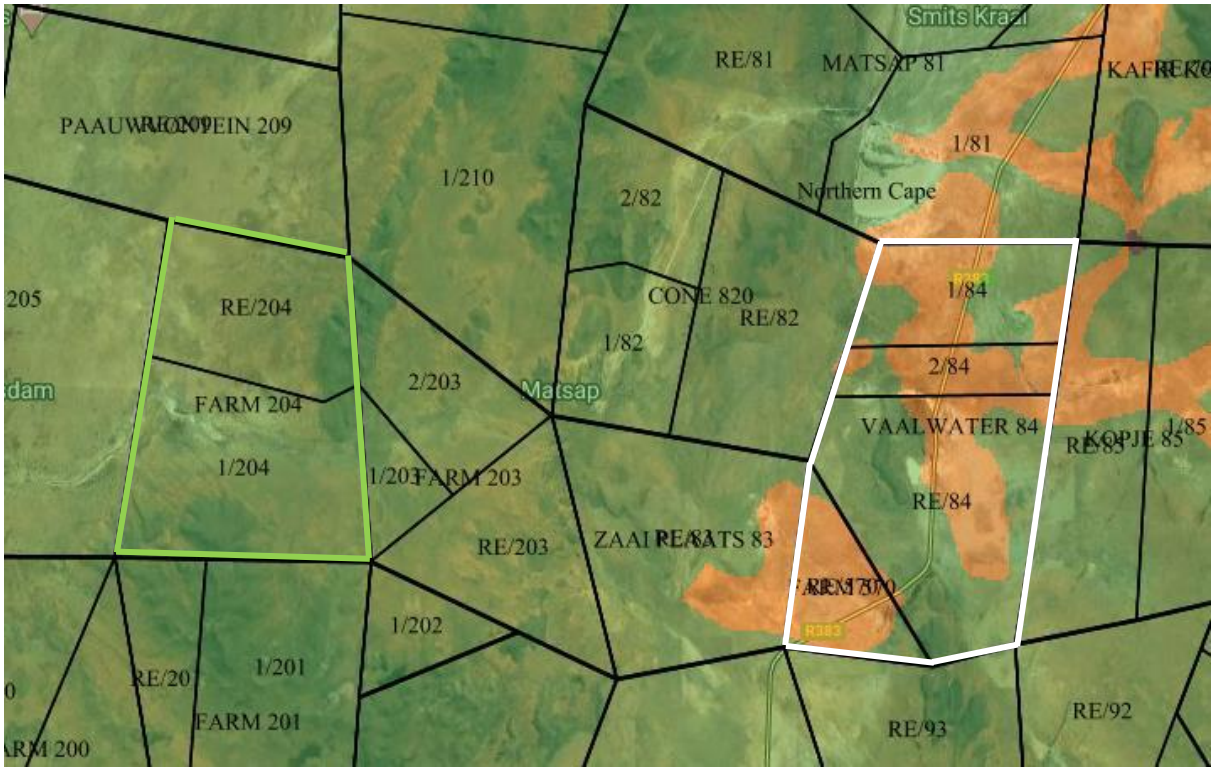

Figure 11: SAHRIS palaeosensitivity map for farms Witdraai No 204 (green polygon),Vaalwater No 84 and Farm No 570 (white polygon). Colour coding as in Figure 13.

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**	Diatomite is composed of fossil algae and so the prospecting will search for fossils; so far there are no records of visible trace fossils from the Kalahari Group of palaeo-pans so it is very unlikely that vertebrate or plant fossils occur on the site. The impact would be negligible
	M	-
	L	-
	L+	-
	M+	-

PART B: Assessment		
	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 diatoms and fossils trapped in features such as palaeo-pans or palaeo-springs and covered by aeolian sands, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**It is very likely/certain that diatoms will be found and destroyed**
	M	**-**
	L	It is extremely unlikely that any visible fossils would be found in the loose soils and sands that cover the area as no traps are visible. 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 aeolian sands do not preserve fossils but might cover features such as palaeo-pans or palaeo-springs that trap or form fossils but no such feature is visible in the satellite imagery. Since there is an extremely high chance that diatoms will be found and destroyed, and a small chance that trapped or transported fossils occur in the sands and 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 high.

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 lavas, sandstones, shales 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 but they might obscure fossil traps such as palaeo-pans or palaeo-springs. No such features are visible in the satellite imagery. It is already known that diatomite occurs in these areas and will be prospected and sampled to determine the extent and quality of the deposits.

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 overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur in traps such as

palaeo-pans or palaeo-springs but no such feature is visible in the satellite imagery. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the contractor, environmental officer or other responsible person once prospecting has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

It is known that diatomite occurs in the prospecting areas and the age and extent of the fossils is unknown. **Samples must be collected and deposited in a recognised repository, such as the McGregor Museum in Kimberley, or a palaeontological research institute, and SAHRA must be notified of what action has been taken**.

7. References

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8. Chance Find Protocol

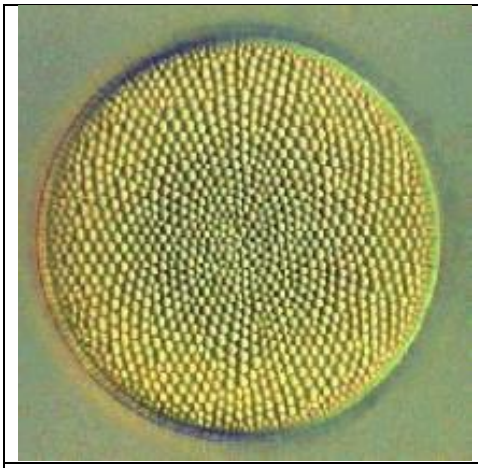
Monitoring Programme for Palaeontology – to commence once the excavations / drilling/sampling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted. **SAMPLES OF DIATOMITE FROM EACH FARM MUST BE DEPOSITED AT A RECOGNISED REPOSITORY**.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the trace fossils such as stromatolites in the dolomites or the Quaternary bones, rhizoliths, traces (for example see Figures 12-14). 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 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 sands

Figure 12: Photographs of various types of rhizoliths in sands and sand dunes from the Kalahari Group.

Figure 13: Photographs of fragmented but robust fossils that have been recovered from Quaternary sands.



Centric diatom

Pinnate diatom

Figure 14: examples of diatoms (diameter 60 microns).

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2024

Present employment: Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone : +27 11 717 6690
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

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current

Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **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 12 - 20 students per year.

vii) **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: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
27 years' experience in PIA site and desktop projects
Selected from recent projects only – list not complete:

- 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
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage
- Adara 2 SEF 2023 for CTS Heritage
- Buffalo & Lyra SEFs 2023 for Nextec
- Camel Thorn Group Prospecting Rights 2023 for AHSA
- Dalmanutha SEFs 2023 for Beyond Heritage
- Elandsfontein Residential 2023 for Beyond Heritage
- Waterkloof Samancor 2023 for Elemental Sustainability
- Zonnebloem WTP 2023 for WSP
- Elders Irrigation 2023 for SRK

- Leghoya WEFS 2023 for Red Cap & SLR

ix) **Research Output**
Publications by M K Bamford up to January 2024 peer-reviewed journals or scholarly books: over 180 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 32 Google Scholar h-index = 40; -i10-index = 120 based on 7068 citations.
Conferences: numerous presentations at local and international conferences.