Palaeontological Impact Assessment for the proposed Beeshoek Mine Optimisation Project, just west of Postmasburg, Northern Cape Province

Desktop Study

For

HCAC

12 April 2021

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Expertise of Specialist

The Palaeontologist Consultant is: 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 Heritage Contracts and Archaeological Contracts, 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:

Executive Summary

A palaeontological Impact Assessment was requested for the updated Beeshoek Mine Optimisation Project for Assmang (Pty) Ltd. The mine is approximately 5km west of Postmasberg, Northern Cape Province. To comply with 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 optimisation and expansion includes extension of the waste rock dumps, open cast pits, infrastructure and power. Palaeontologically very highly sensitive rocks that may preserve stromatolites, of the Campbell Rand Subgroup (Ghaap Group, Transvaal Supergroup) occur along the eastern margin of the mine area but these have already been mined and disturbed. The western part lies on Quaternary Kalahari sands, alluvium and calcrete. There is a very small chance that fossils may occur in palaeo-pans BUT no such feature is visible. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once the surveyor and/or the environmental officer walks the expansion area and northern route, they should be photographed, position recorded, removed and stored. Photographs sent to the palaeontologist will enable him/her to assess the scientific importance of the fossils and act accordingly.

The Impact Significance:

Negative	**Low**	**Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.**	**- 1 – 5**

Table of Contents

1. Background

An Environmental Impact Assessment (EIA) was done for the Beeshoek Iron Ore Mine, approximately 5km west northwest of the town of Postmasburg, Northern Cape Province (Figures 1-4) As part of the proposed Optimisation project, including rehabilitation and re-vegetation, the mine footprint will expand so the reports need to be amended.

Beeshoek is situated in the Tsantsabane Local Municipality, with neighbouring towns being Postmasburg, located 7km east of the mine and Kathu located 70km north of the mine. Mining at Beeshoek was established in 1964 with a basic hand sorting operation. In 1975 a full Washing and Screening Plant was installed. Because of increased production, Beeshoek South, a southern extension of the Beeshoek Mine, was commissioned during 1999 on the farms Beesthoek and Olynfontein.

Assmang (Pty) Ltd is the holder of the new order rights in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) in respect of high-grade hematite iron ore deposits at Beeshoek on the farms Beesthoek and Olynfontein. The mining method currently entails an opencast mining operation, which consists of five (5) active opencast pits (Village Opencast Pit, HF Opencast Pit, BF Opencast Pit, East Opencast Pit, and BN Opencast Pit). Although other opencast pits are dormant at this time, these are continuously assessed in terms of their economic value. The current resources of the Mine are approximately 87 million tonnes with a reserve of about 26 million tonnes.
Beeshoek can be broadly categorised as follows:

a) Northern mining area (North Mine): This area comprises active as well as historical mining areas. A number of small quarries and mine residue dumps of various categories are located within this area. The area also includes the existing iron ore beneficiation plant, tailings storage facility (slimes dam), as well as the North Opencast Pit (BN Opencast Pit);
b) Main Offices, village (since demolished) and recreational area; and
c) Southern mining area (South Mine): This area comprises large opencast pits and associated Waste Rock Dumps (WRDs). The Village Opencast Pit and associated WRD are the main activities in this area. This area also includes a crushing and screening area as pre-preparation of the Run of Mine (ROM) iron ore before being routed by overland conveyor to the Iron Ore Beneficiation Plant located at North Mine.

Project Description

Regulation 23 of the MPRDA states in Section 1(a), that subject to subsection 4, the Minister must grant a mining right if the mineral can be mined optimally in accordance with the mining work programme. The mine has been awarded a Mining Right by the Department of Mineral Resources (DMR; now Department of Mineral Resources and Energy (DMRE)) and therefore has an obligation to give effect to the following:

The ongoing development and improvement of the Mining Work Programme which details the planned mining activities to be followed in order to mine the mineral resource optimally. Optimal mining of minerals must be undertaken, as the Minerals and Petroleum Board may recommend to the Minister to direct the holder of a mining right to take corrective measures if the Board establishes that the minerals are not being mined optimally in accordance with the Mining Work Programme. The Minister may, on the recommendation of the Board, suspend or cancel a mining right if the Minister is convinced that any act or omission by the holder justifies the suspension or cancellation of the right.

Beeshoek Mine is actively investigating opportunities for the continued and sustainable mining of iron ore reserves within the approved Mining Rights Area. This application for Environmental Authorisation specifically gives effect to that and includes the following projects:

Amendments to certain conditions which have been identified in the NEMA Regulation 34 Audit as “not sufficient or not practical” to address activities on site. The specific conditions that were identified for exclusion or amendment are:

- An Environmental Audit Report as contemplated in regulation 55(1)(c) must be submitted bi-annually (from the date on which the permit was granted) to the Regional Manager: Mineral Regulations.
- All vehicles will have mufflers to minimise noise emissions.
- Rehabilitation of the dumps and dams, stormwater drainage (not relevant to palaeontology)
- Specific Demarcation of Run of Mine (ROM) Stockpiles on South Mine;
- Amendments to the design of existing WRDs in terms of the increase in heights, and allowance for final slope, which will result in extension of footprints;
- Increase of Opencast Pit footprint areas, as well as the undertaking of detrital mining;
- Development of a Jig Plant (this area will be located in the vicinity of the current plant) for the beneficiation of discard and low-grade Iron Ore;
- Development of a WHIMS Plant for the beneficiation of slimes;
- Development of a new surface water dam for the purposes of the Beneficiation
- Optimisation Projects (Jig and WHIMS Plants); and
- Development of supporting infrastructure such as power lines, roads, pipelines and improvements to storm water management systems where applicable.

The purpose of this project is to give effect to the Regulation 23 MPRDA requirements for the optimisation of a Mining Right, as well as the implementation of the best practical environmental management measures for the operation and management of the Waste Rock Dumps. Further to this, the proposed Beeshoek Low-Grade Beneficiation Optimisation Project is to allow Beeshoek Iron Ore to optimise the mining process and reduce mineral waste on site (in line with the National Waste Management Hierarchy). This will be done by implementing two additional Beneficiation Projects, namely a new WHIMS Plant to rework the existing slimes from the Slimes Dam and a new Jig Plant to rework the existing low-grade stockpile (Discard Dump). This project will have numerous economic and environmental benefits.

This application is for the purposes of a Basic Assessment Process in terms of the 2014 NEMA EIA Regulation 982 of 2014 (Regulation 983, Regulation 984 and Regulation 985) as amended in 2017.

An updated Palaeontological Impact Assessment was requested for the Beeshoek Mine Optimisation project. To comply with 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 here.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (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
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A

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	N/A
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

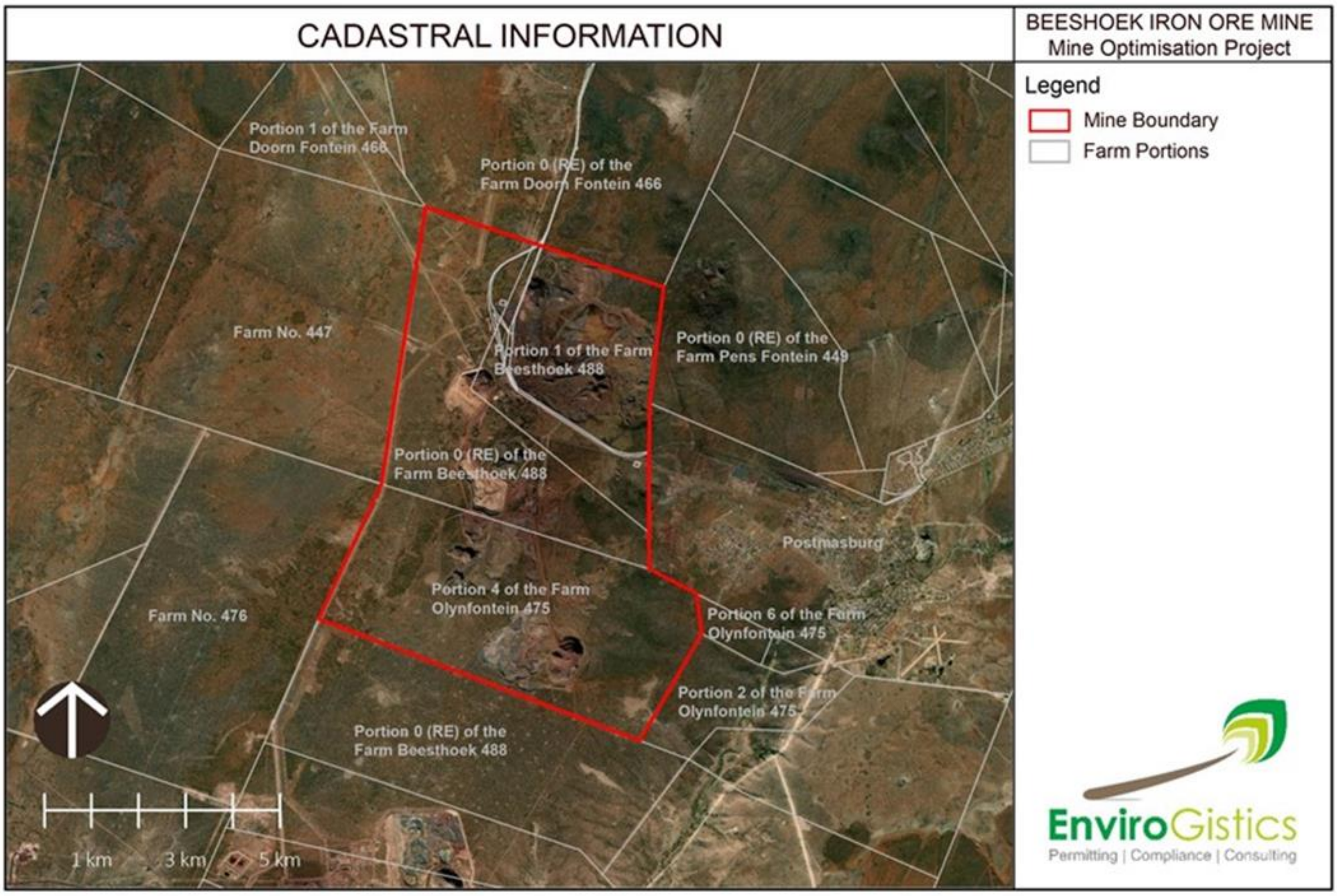

Figure 1: Cadastral map showing the farm boundaries (red outlines) of the mine areas. (Taken from Beeshoek ESR_D2 document, fig 2).

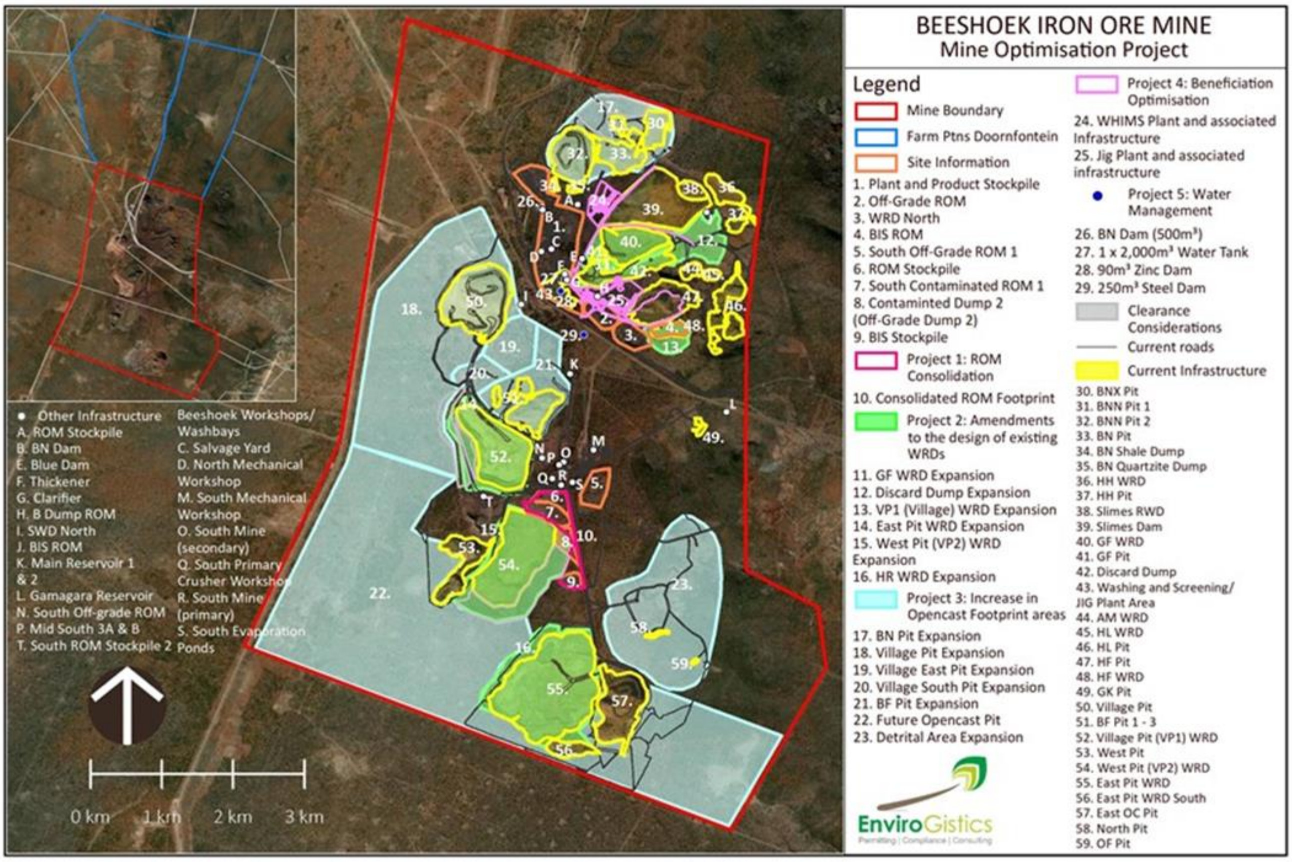

Figure 2. Whole area of the Beeshoek Mine expansion project (Fig 3 Beeshoek ESR_D2 document).

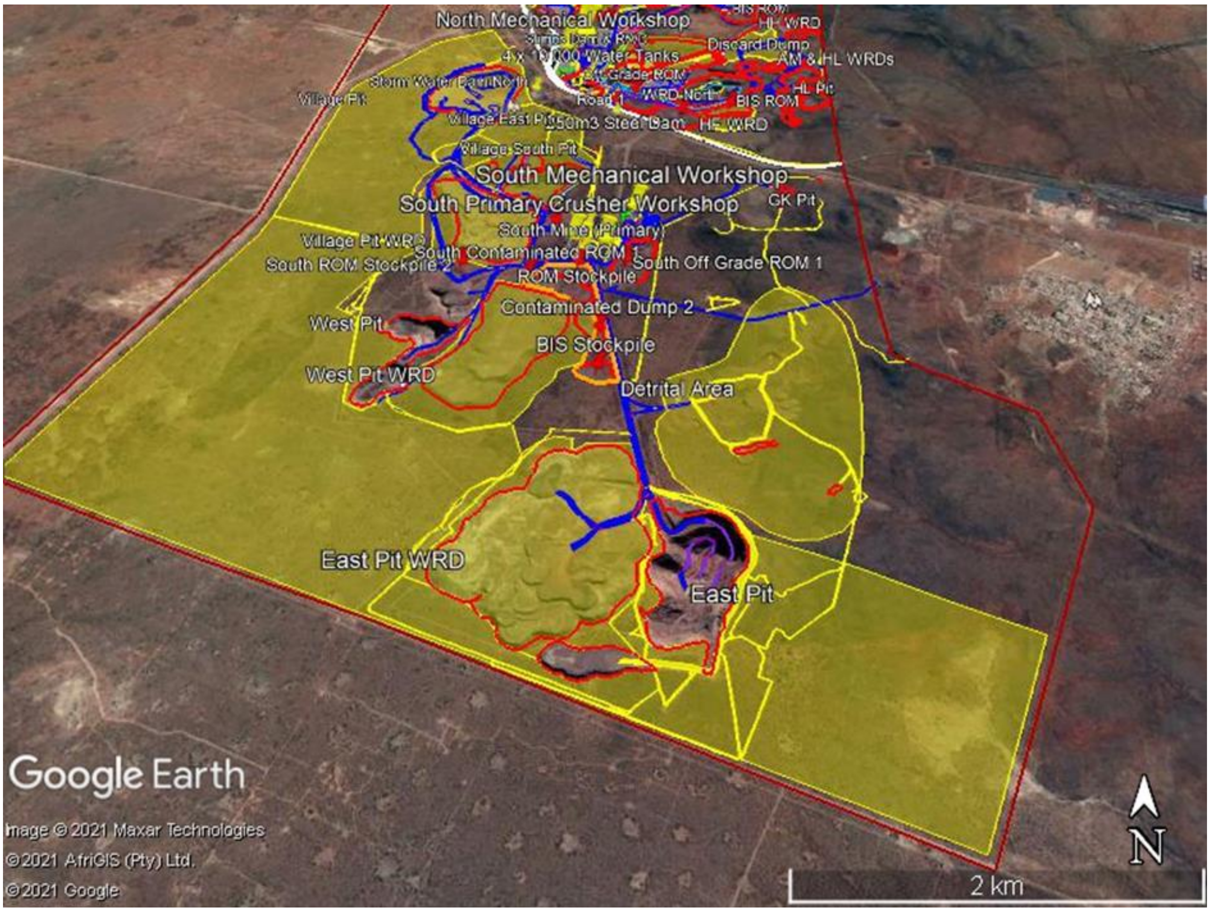

Figure 3: Southern part of Beeshoek Mine expansion project on farm Olynfontein. Note the northeast corner of the farm does not have any proposed development.

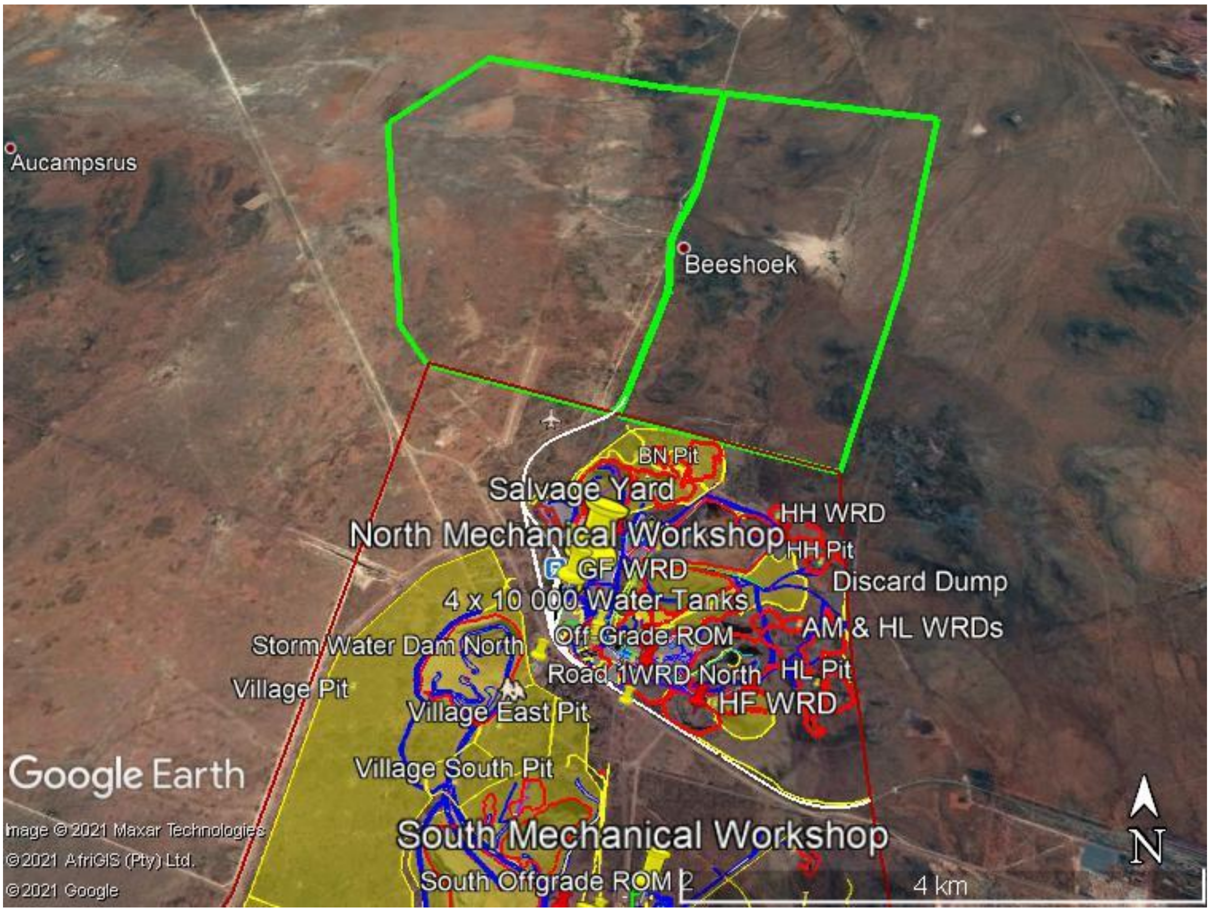

Figure 4: Northern part of Beeshoek Mine optimisation project on Farm Beeshoek to the south with the green outline extending around Farm Doornfontein 446 0(RE).

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

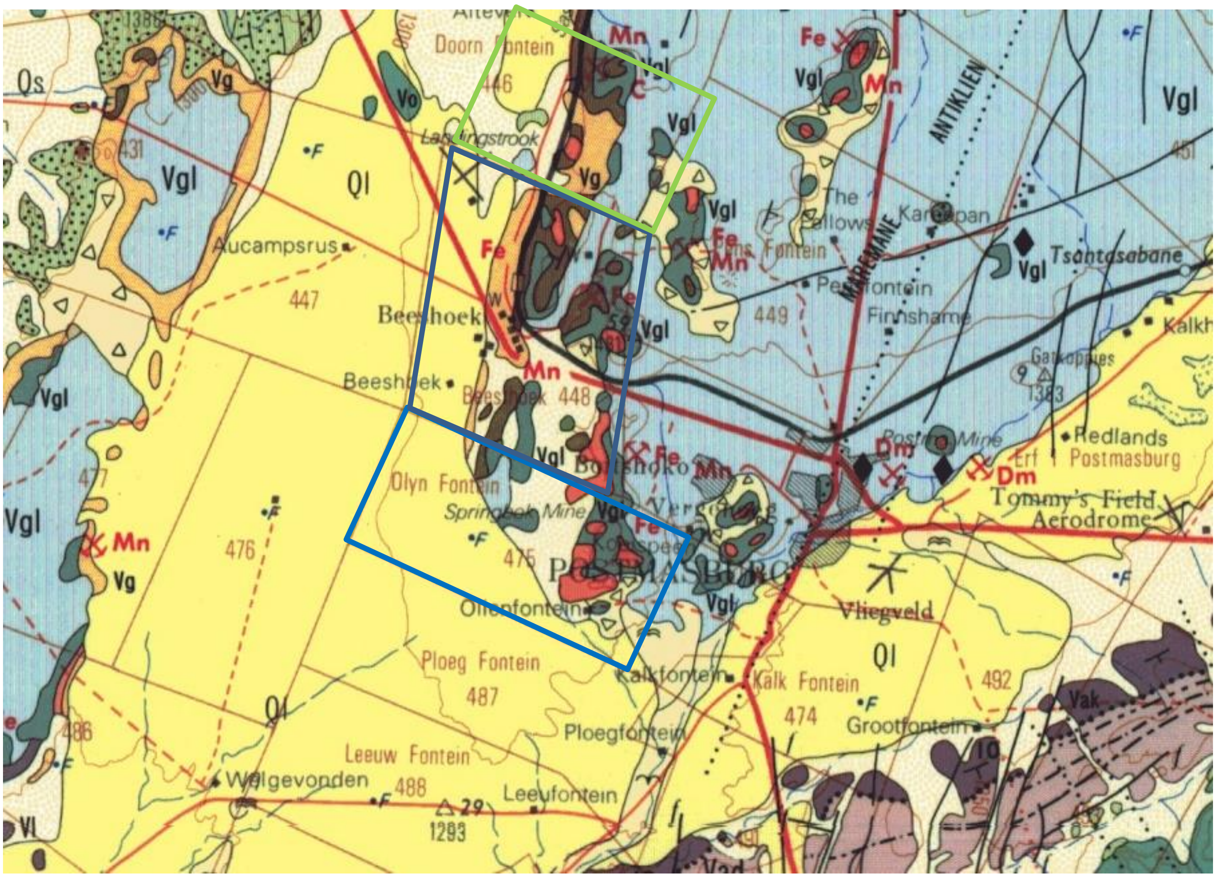

Figure 5: Geological map of the area around Beeshoek and Olynfontein Farms, near Postmasburg. Farm Doornfontein route is in the green rectangle. The location of the proposed optimisation project is indicated within the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 1984.

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

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Kalahari Group	Alluvial and aeolian sands	Last ca 2.5 Ma
Ql	Kalahari Group	Calcrete, limestone, alluvium	Last ca 2.5 Ma
T-Qk	Sands overlying Tertiary rocks	Alluvial and aeolian sands	Last 65 Ma
Vha	Hartley Fm, Olifantshoek SG (and Mapedi Fm).	Andesite, tuff, conglomerate	Ca 1893 Ma
Vlu	Lucknow Fm, Olifantshoek Sequence	Quartzitic limestone	>1893 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vg	Gamagara Fm, Griqualand West Sequence	Shale, quartzite, conglomerate	>1893 Ma
Vo	Ongeluk Fm, Posmasburg Group, Transvaal SG	Andesite, lava	2222 Ma
Vak	Kuruman Fm, Asbestos Hills Subgroup, Griqualand Sequence	Banded iron formation	2500 Ma
Vgl	Lime Acres Mbr, Campbell Rand Subgroup, Ghaap Group, Transvaal SG	Light blue: Dolomitic limestone, chert Dark blue/teal: chert and chert breccia	>2420 Ma

In the Griqualand West Basin, the Ghaap Group of the Transvaal Supergroup, is divided into four subgroups, from the oldest, Schmidtsdrift, Campbell Rand, Asbestos Hills and Koegas Subgroups (Eriksson et al., 2006, p. 244). The Koegas Subgroup is overlain by the Postmasburg Group and the latter is divided into the lower Makganyene Formation and the Ongeluk Formation (ibid). There are three formations in the Asbestos Hills Subgroup, from the base, the Kliphuis, Kuruman and Danielskuil Formations, with all three composed of iron-formation. The Asbestos Hills Subgroup is dated at about 2500 Ma.

The Campbell Rand Subgroup has nine Formations (Eriksson et al., 2006; Beukes et al., 2016) and they form a stromatolitic carbonate platform. The Campbell Rand Subgroup occurs around the basin margin on the craton. Platform margin and lagoonal dolomites are manganese-rich, whereas basinal dolomites are iron-rich, and intertidal to supratidal deposits are virtually free of iron and manganese (Beukes, 1987). Beeshoek is on iron-rich rocks and lies partly on the Manganore iron formation (Figure 5). Three types of carbonate platform rocks occur in this formation, varying depending on the degree of stratification and limestone. For example the Lime Acres Member is predominantly composed of dolomitic limestone with different amounts of chert. This term is on the 1977 geological map but is seldom used today so the stratum will be referred to as the Campbell Rand Subgroup (Altermann and Schopf, 1995).

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.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 6-7. The site for mine expansion is on non-fossiliferous iron formation of the Kuruman Formation, and partly on potentially fossiliferous Campbell Rand Subgroup dolomitic limestone and chert, as well as on sands, alluvium, limestone and calcrete. Aeolian Kalahari sands were derived from farther to the northwest (Goudie and Wells, 1995), and finally deposited in this region during the Quaternary. Since they are windblown the sands are not in primary context, nor do they preserve any fossils.

Dolomites of the Campbell Rand Subgroup can preserve stromatolites. These are trace fossils formed by the photosynthetic activity of colonies of cyanobacteria and blue-green algae that thrived in warm, shallow seas. The process of photosynthesis uses sunlight for energy and carbon dioxide from the atmosphere to create long chain carbons for their growth and releases water and free oxygen. The oxygen is taken up by minerals such as iron, calcium, magnesium, manganese and aluminium. Stromatolites are layers and layers of calcium carbonate, calcium sulphate and magnesium sulphate and so are good evidence of early life. They can form domes, layers or columns (Figures in Appendix A).

The Quaternary surface limestone is also potentially fossiliferous, but fossils can only be preserved if there are spring or palaeopan deposits where wood, plants or bones can be entrapped and preserved in the calcrete or silcrete that occasionally forms in such settings. No such deposits have been recorded from this site, and the Google Earth imagery does not show any pan or spring deposits. According to Goudie and Wells (1995) three factors are required for the formation of pans, namely a setting where the fluvial system is not fully integrated, salt weathering and aeolian deflation occur. The latter two conditions apply to this environmental setting, but the first does not as the site is on a slope. Therefore, it is extremely unlikely that there are any pans in the site or any fossils in the sands.

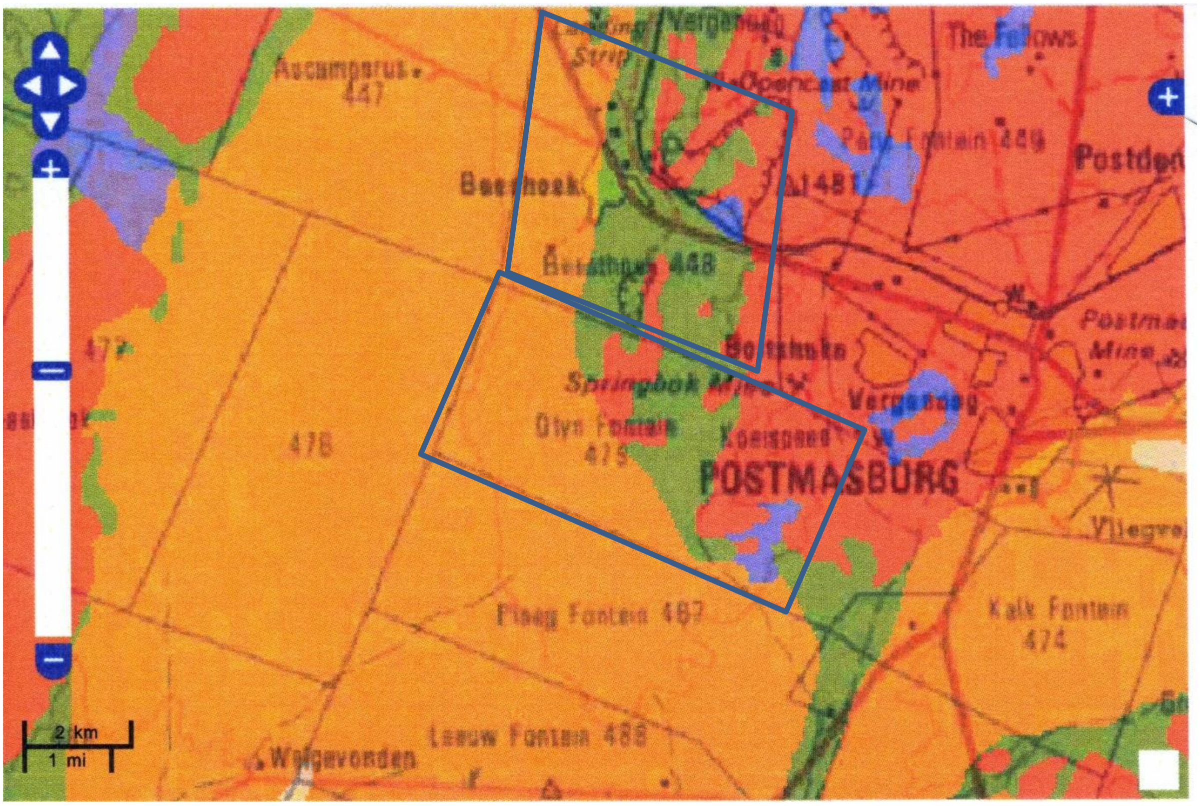

Figure 6: SAHRIS palaeosensitivity maps for the site for the proposed Beeshoek project shown within the yellow rectangle. Background colours indicate the following degrees of

sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Plio-Pleistocene fossils have been recovered from palaeo-pans in the region, for example Kathu Pan and Townlands (Walker et al., 2017,) but there are no pans evident in the project footprint. There are palaeontological and archaeological sites in the Kuruman hills, Ghaap Group, but not in the project footprint.

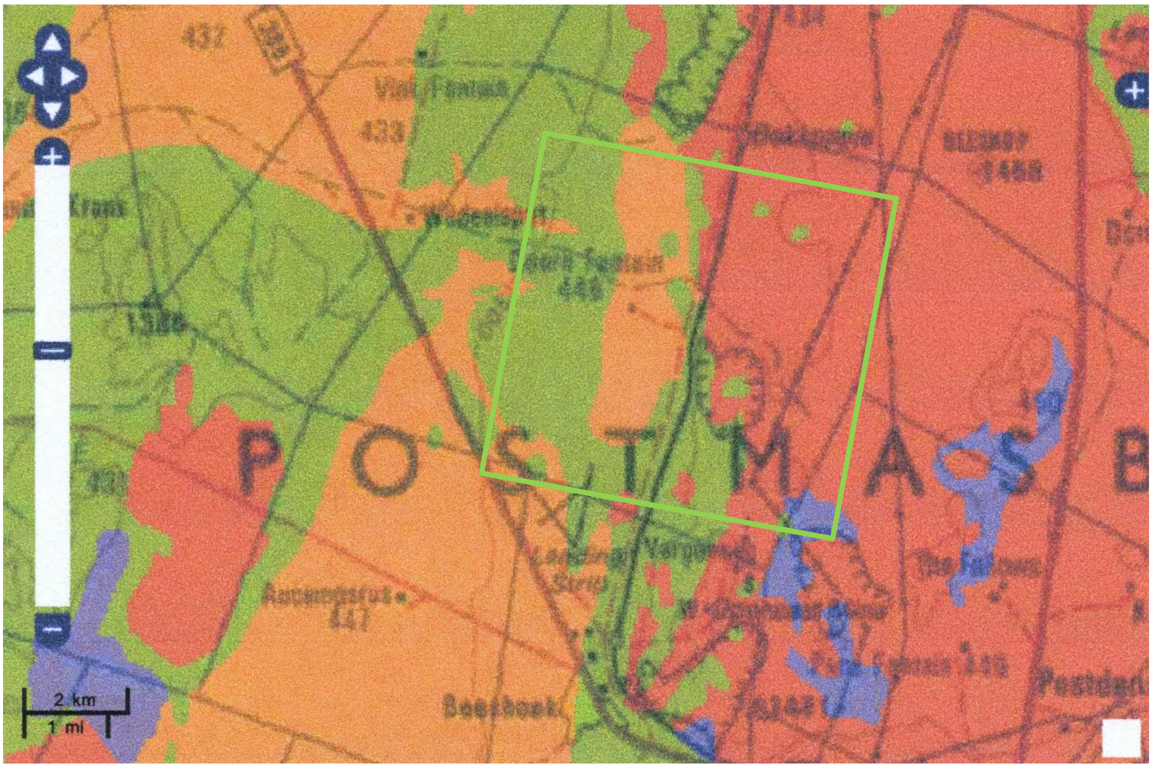

Figure 7: SAHRIS palaeosensitivity map for the northern part of the project on Farm Doornfontein 446 (corresponding to the bright green lines in Figure 4). Background colours – see Figure 6).

From the SAHRIS maps above, the area is indicated as very highly sensitive (red) along the east for the Lime Acres Formation (Ghaap Group), highly sensitive (orange) for the Kalahari sands and surface limestone, or moderately sensitive (green) for the aeolian sands so a desktop study is presented here.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in the table provided by the EIA company. NOTE not reproduced here because it is the same for all the specialists

Table 3: impacts for four stages 1 = planning; 2 = construction; 3= operation; 4 = closure.

Assessments for Palaeontology	1	2	3	4
Status of Impact	N	P	0	0
Impact Extent	low	low		
Impact Duration	3	1		
Impact Probability	1	1		
Impact Intensity	-1	+1		
Impact Significance	-1-5	-1-5		
MITIGATION = removal of any fossils found in the planning stage. If the surveyor, environmental officer sees any fossils on the surface or along the routes in the northern section that could be damaged, the position of the fossils should be marked with GPS points, the fossils photographed and then removed to a safe storage site until a palaeontologist can assess their scientific worth. Fossils should be given to a recognised repository (e.g. the McGregor Museum in Kimberley) with the relevant site data.	Mitigation during this phase			

Negative	**Low**	**Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.**	**- 1 – 5**

There will be no impact for the operational and closure (decommissioning) phases.
No monitoring is required if there are no fossils or if the fossils have been rescued already.

The status of the impact during the planning phase and before mitigation (removal of fossils) will be negative; it becomes positive if fossils are absent or have been removed.

- The extent of the impact is low because only fossils in the expansion area or along the routes on Doornfontein Farm could be affected.
- The duration of the impact would be permanent if fossils are not removed, but is low if they are removed.
- The probability of any fossils occurring in the expansion footprint that is already highly disturbed from prior mining activities, or along the route, is very low because there are no palaeo-pans or palaeo-springs visible on the satellite imagery.
- The intensity of the impact is only local.
- Significance of the impact is 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 aeolian sands, sandstones and calcrete are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. No palaeo-pans or palaeo-springs that could entrap fossil, are visible in the satellite imagery, therefore it is extremely unlikely that they occur along the northern section proposed routes. Only stromatolites might occur in the Campbell Rand Subgroup dolomites but they are not common.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils in the loose sands or calcretes of the Quaternary or in the dolomites of the Campbell Rand Subgroup. There is a very small chance that fossils may occur in palaeo-pans BUT no such feature is visible. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once the surveyor and/or the environmental officer walks the route and expansion areas, they should be photographed, position recorded, removed and stored. Photographs sent to the palaeontologist will enable him/her to assess the scientific importance of the fossils and act accordingly.

7. References

Altermann, W., Schopf, J.W., 1995. Microfossils from the Neoarchaean Campbell Group, Griqualand West Sequence of the Transvaal Supergroup, and their palaeoenvironmental and evolutionary implications. Precambrian Research 75, 65-90.

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Porat, N., Chazan, m., Grün, R., Aubert, M., Eisenmann, V., Kolska Horwitz, L., 2010. New radiometric ages for the Fauresmith industry from Kathu Pan, southern Africa: Implications for the Earlier to Middle Stone Age transition, Journal of Archaeological Science 37, 269–283.

Walker, S.J.H., Lukich, V., Chazan, M., 2014. Kathu Townlands: A High Density Earlier Stone Age Locality in the Interior of South Africa. PLoS ONE 9(7): e103436. doi:10.1371/journal.pone.0103436

8. Chance Find Protocol

Programme for Palaeontology – to commence once the expansion area and routes are surveyed by the surveyor or environmental officer. Planning/pre-construction phase

1. The following procedure is only required if fossils are seen on the surface when surveyed and any palaeo-pan or palaeo-spring feature is recognised, or if stromatolites are seen in the eastern parts.
2. If any fossiliferous material (plants, insects, bones, or stromatolites) is seen it should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 7-9). 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 scientifically important fossil material as assessed from the submitted photographs, then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the site and excavate (having obtained a SAHRA permit).
6. Stromatolites, 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.
7. Annual reports must be submitted to SAHRA as required by the relevant permits.
8. If no good fossil material is recovered then the site inspection by the palaeontologist will not be necessary.
9. If no fossils are found during the survey then no further palaeontological impact assessment is required.

Appendix A – Examples of stromatolites (Campbell Rand Subgroup), and a Quaternary palaeo-pan and fossils

Figure 8: Stromatolite domes seen from the surface. Scale = 15cm

Figure 9: Weathered stromatolite seen as a depression with concentric circles.

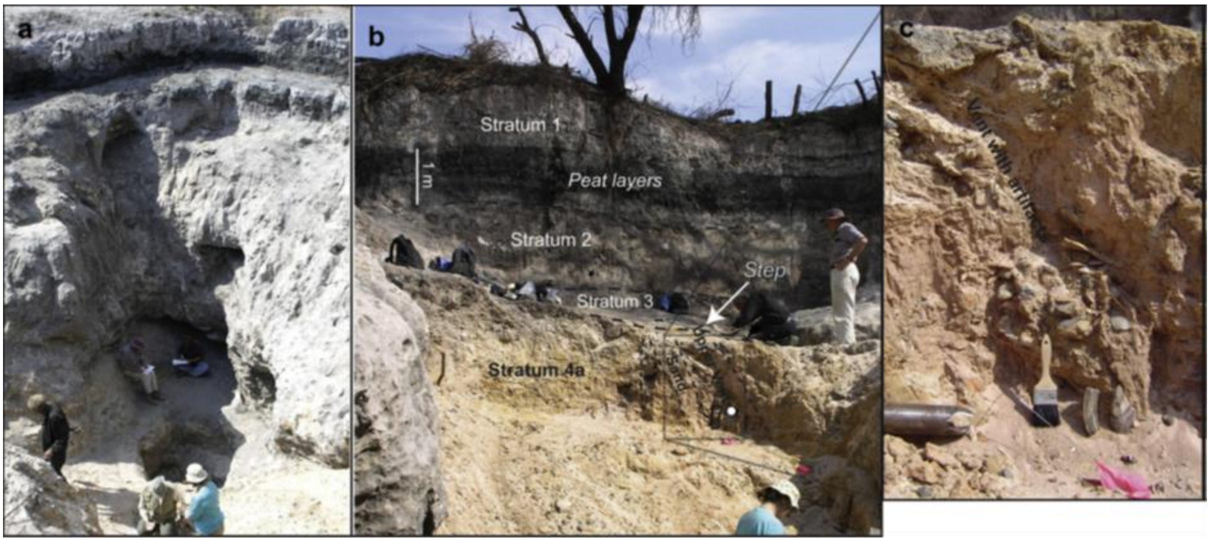

Figure 10: Example of a palaeo-pan deposit, Kathu Pan, near Kuruman and Kathu. From Porat et al., (2010).

Figure 11: Examples of bone fragments from quaternary sediments and could be found associated with pans.

Figure 12: Examples of silicified wood from Pleistocene sediments

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 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	12	3

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

xi) Research Output

Publications by M K Bamford up to December 2019 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 = 80
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)