Palaeontological Impact Assessment for the proposed Botterblom Wind Energy Facility, north of Loeriesfontein, Northern Cape Province

Desktop Study (Phase 1)

For

Beyond Heritage (Pty) Ltd

18 September 2021

Prof Marion Bamford
Palaeobotanist
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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 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: 

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Botterblom Wind Energy Facility (WEF) on a portion of the Farm Sous 226, about 53 km north of Loeriesfontein, Northern Cape Province.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the Ecca Group of the Karoo Supergroup. It lies on non-fossiliferous dolerite in the western section, on potentially fossiliferous Tierberg Formation shales in the central section, and on very highly sensitive shales of the Whitehill Formation in the southernmost section. A Fossil Chance Find Protocol should be added to the EMPr for these sections. For the Whitehill Formation, however, if turbines will be placed in the southernmost section, then a palaeontologist will be required to visit the site, look for fossils, and collect any found once a relevant permit from SAHRA has been obtained.

Table of Contents

1. Background

FE Botterblom (Pty) Ltd (hereafter the Applicant) is proposing the development of a wind energy facility (WEF) and associated infrastructure on a site located approximately 53 km north of Loeriesfontein in the Northern Cape province of South Africa. The proposed development, to be known as Botterblom WEF, will generate electricity that will feed into the National Grid.

The proposed WEF development site is located approximately 53km north of Loeriesfontein, 87 km west of Brandvlei and 146 km south of Pofadder in the Northern Cape. The site can be reached via a gravel Granaatboskolk / Zout Dwaggas Road, that branches off the R357 (Figure 1). The Botterblom WEF footprint is approximately 5 736 hectares (ha) and will be located on a Portion of the Remainder of the Farm Sous 226 (Figure 1). The existing Khobab WEF is located directly north while Loeriesfontein2 WEF is located north-east of the proprosed Botterblom WEF site.

The Botterblom WEF will consist of up to 54 wind turbines, with a generation capacity of up to 6.5 MW per turbine (Figure 2). Each turbine will have a hub height of up to 150m and a rotor diameter of up to 175m. The final turbine model to be utilised will only be determined closer to the time of construction, depending on the technology available at the time.

Additional ancillary infrastructure to the WEF would include underground and above-ground cabling between project components, onsite substation/s, foundations to support turbine towers, internal/ access roads (up to 10 m in width) linking the wind turbines and other infrastructure on the site, and permanent workshop area and office for control, maintenance and storage. As far as possible, existing roads will be utilised and upgraded (where needed) with the relevant stormwater infrastructure and gates constructed as required. The perimeter of the proposed WEF may be enclosed with suitable fencing. A formal laydown area for the construction period, containing a temporary maintenance and storage building along with a guard cabin will also be established.

Additionally, the Applicant is proposing to construct the associated on-site substation and power line, both with a capacity of up to 132kV. This would feed into the existing national electricity grid at the Helios Main Transmission Substation (MTS) located within the property itself. This associated electrical infrastructure will require a separate Environmental Authorisation and is being conducted as a part of a separate Basic Assessment (BA) process.

A Palaeontological Impact Assessment was requested for the Botterblom WEF project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 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	Section 6
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A

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

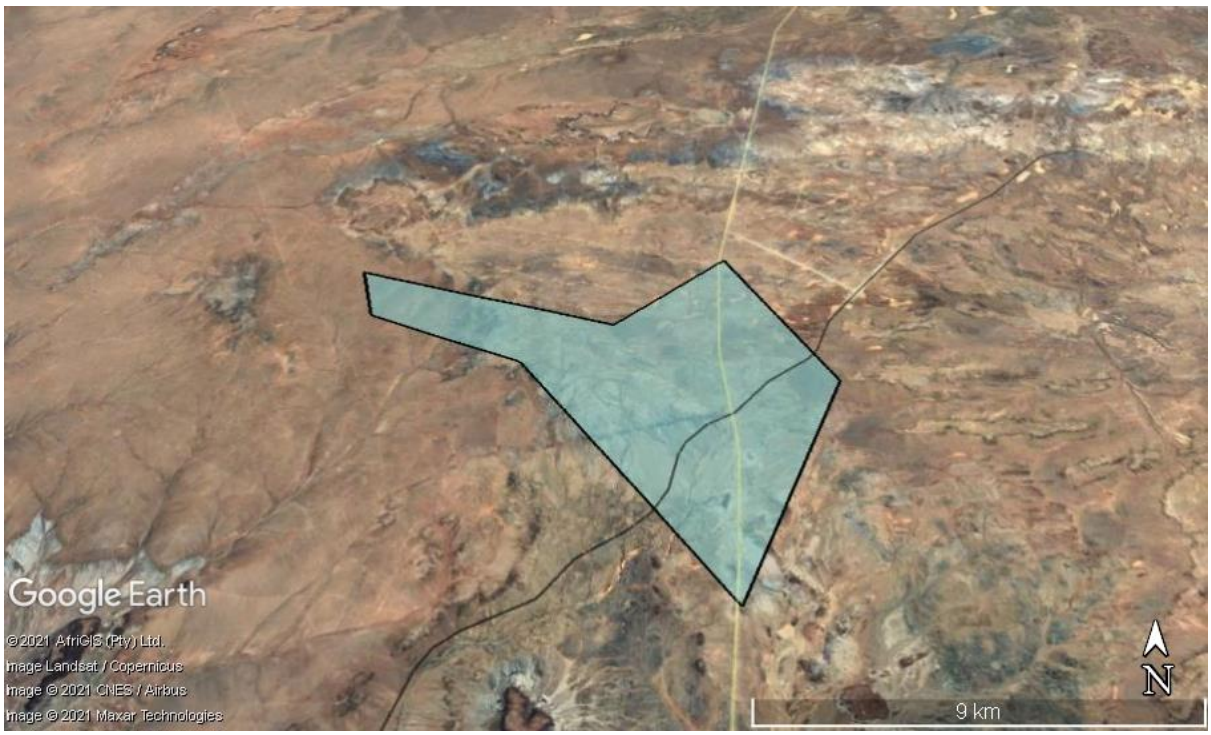


Figure 1: Google Earth map of the proposed development of a WEF on Farm Sous 226, the Botternlom WEF, with the section of the farm shown by the grey polygon. Map supplied by EnviroInsight.

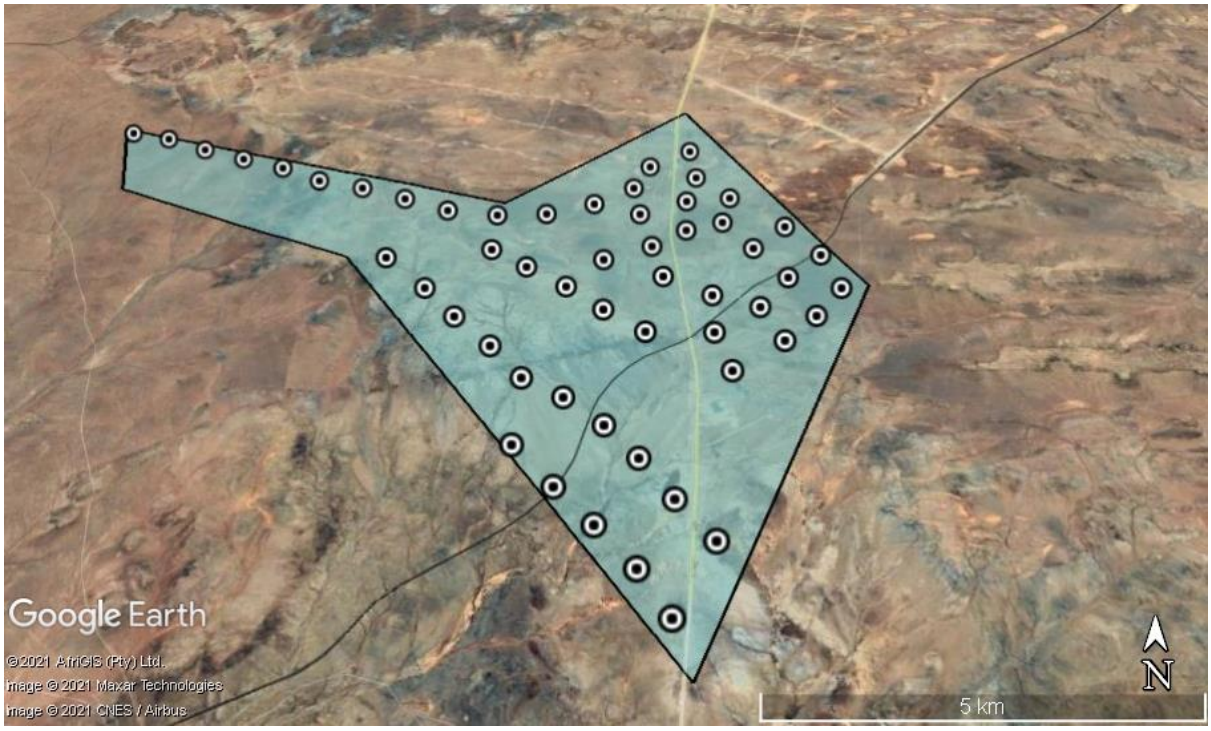


Figure 2: Google Earth map of the proposed positions of the turbines for the Botterblom WEF project on a portion of Farm Sous 226.

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 site for the Botterblom WEF is in the western part of the Karoo Basin that preserves the lower strata of the Karoo Supergroup rocks.

The Karoo Supergroup rocks cover a very large proportion of South Africa, representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa. Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the west and central part are the following formations, from base upwards: Prince Albert Formation, Whitehill Formation, Collingham Formation, Laingsburg / Ripon Formations, Tierberg / Fort Brown Formations, and Waterford Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

Overlying the Ecca Group are the rocks of the Beaufort Group that has been divided into the lower Adelaide Subgroup for the Upper Permian strata, and the Tarkastad Subgroup for the Early to Middle Triassic strata. As with the older Karoo sediments, the formations vary across the Karoo Basin.

Large exposures of Jurassic dolerite dykes occur throughout the area. These intruded through the Karoo sediments around 183 million years ago at about the same time as the Drakensberg basaltic eruption.

After several episodes of tectonic uplift, weathering, erosion and re-deposition during the Cretaceous and Tertiary periods there are large expanses of Kalahari Group sands that cover much of the older rocks. Recognised as one the largest paleo-ergs in the world (Partridge et al., 2006) this group of fluvial, aeolian and dune sands, and alluvium and rubble was sourced from the older rocks in the region.

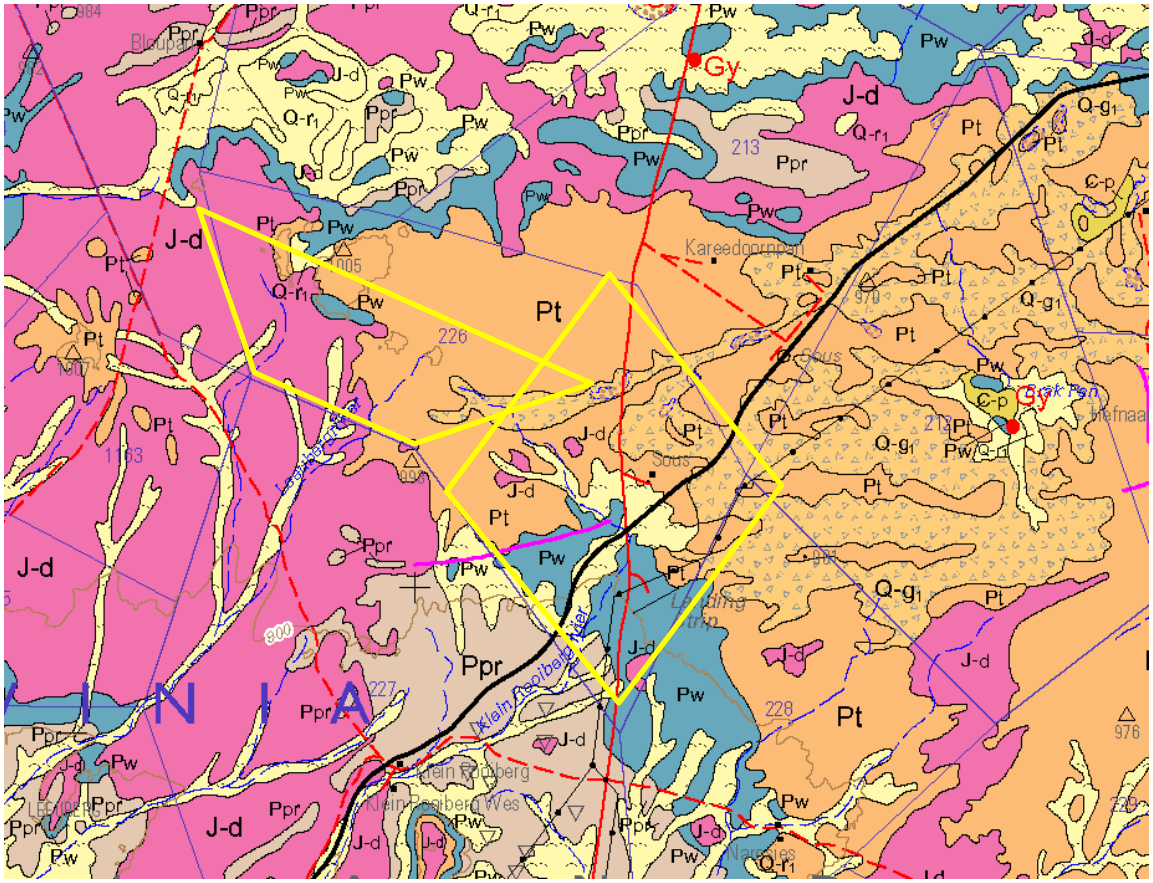


Figure 3: Geological map of the area around the Farm Sous 226 and the Botterblom WEF. The location of the proposed project is indicated within the yellow rectangles. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3018 Loeriesfontein.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006; dates from Barbolini et al., 2018) SG = Supergroup; Fm = Formation; Ma = million years; ka = thousand years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qn	Quaternary	Alluvium	Neogene, ca 2.5 Ma to present
Qr1	Quaternary	Sandy soil	Last ca 50ka
Qg1	Quaternary	Dolerite gravel	Last ca 50 ka
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pt	Tierberg/Fort Brown Fm, Ecca Group, Karoo SG	Brown to grey shale	Middle Permian ca 269 – 266 Ma
Pw	Whitehill Fm, Ecca Group, Karoo SG	Carbonaceous shale	Middle Permian, ca 283 – 275 Ma
Ppr	Prince Albert Fm, Ecca Group, Karoo SG	shale	Early Permian, ca 290- 283 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Ecca Group shales and the Quaternary sands. The red colour (very highly sensitive) refers to the Whitehill Formation, the orange (highly sensitive) to the Tierberg Formation, and the green colour refers to the Quaternary Alluvium.

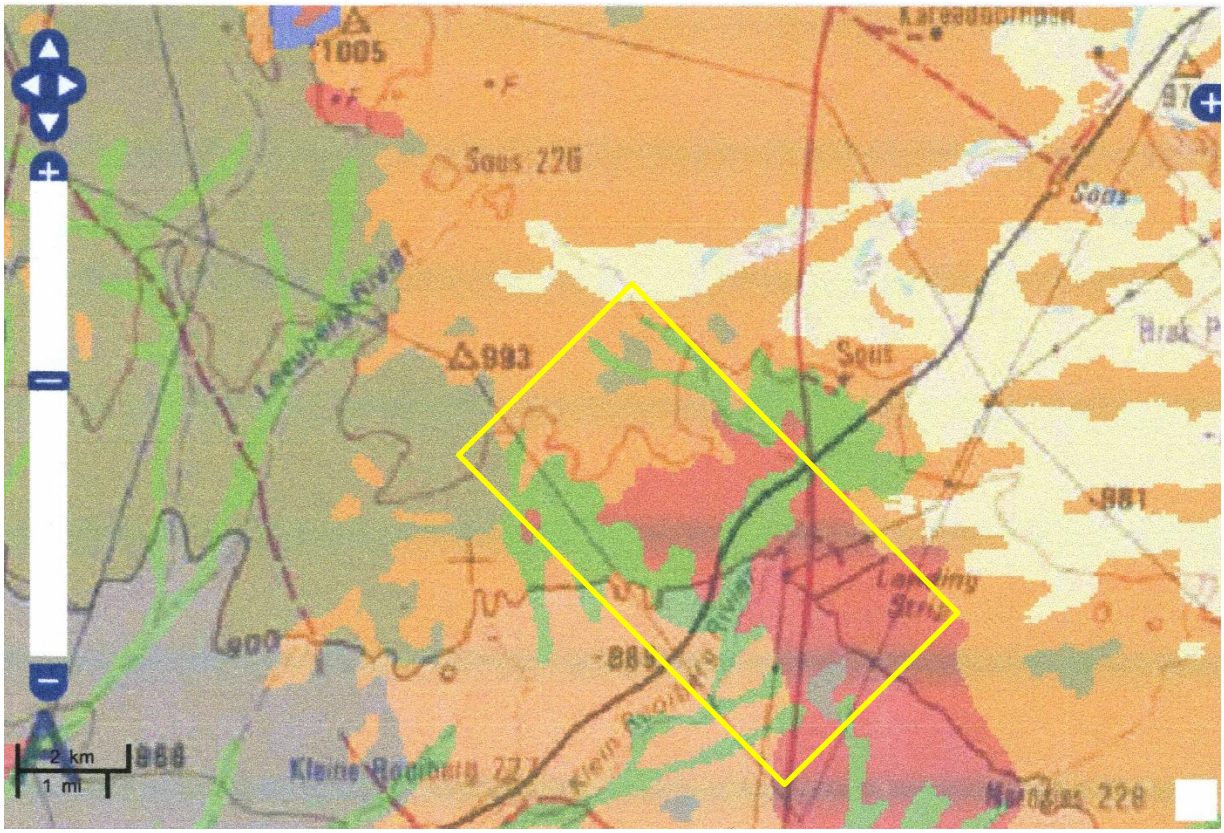


Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Botterblom WEF on Farm Sous 226 shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The Whitehill Formation is composed of mudrocks that weather white on the surface so they are easy to recognise. Un-weathered mudstones are dark. This western stratum can be considered a distal equivalent of part of the Vryheid formation in the central and western part of the Karoo Basin (Johnson et al., 2006), or considered as a distal equivalent of the Pietermaritzburg Formation (Rubidge, 2005). The Whitehill Formation has marine fossils such as the swimming reptile *Mesosaurus* (Oelofson and Araujo, 1987; Modesto, 2010) and the arthropod *Notocharia/Spirophyton*, as well as some terrestrial fossils of the Glossopteris flora typical of the Vryheid Formation.

In the westernmost part of the basin the Tierberg Formation is predominantly argillaceous. In the northwest of its occurrence where it is in contact with the Collingham or Whitehill Formations, it grades up into the arenaceous overlying Waterford Formation (Johnson et al.,

2006). Trace fossils of *Nereites, Planolites* and *Zoophycus* can be found in the fine mudstones (Johnson et al., 2006).

Quaternary alluvium very, very seldom preserves fossils and they would be fragmented and transported from another site so their scientific value is minimal.

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	Quaternary alluvium does not preserve fossils. Shales of the Whitehill or the Tierberg Fm might preserve trace fossils or vertebrates; so far there are no records from this region so it is very unlikely that fossils occur on the site. The impact would be unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.

PART B: ASSESSMENT		
SPATIAL SCALE	L	Since the only possible fossils within the area would be trace fossil or rare vertebrate fossils plants from the Whitehill or Tierberg Fms in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	It is extremely unlikely that any fossils would be found in the loose sand that will be excavated but trace or vertebrate fossils might occur in the southern sector. Therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.
	L	

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 the right type and age to contain fossils in the southern part but not in the northwestern part. Since there is a small chance that fossils from the Tierberg Formation 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 contain fossil traces, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. It is not known if there are fossils in the Tierberg Formation. Although the Whitehill Formation is indicated as very highly sensitive, only very few specimens of *Mesosaurus* are known. Trace fossils are more common.

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 alluvium of the Quaternary. There is a very small chance that trace fossils may occur in the shales of the early Permian Tierberg Formation so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations for foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

If turbines and infrastructure are going to be placed in the southernmost part of the project area, on the section indicated in bright blue on the geology map (Pw, Figure 3) or red on the SAHRIS map (Figure 4), then a palaeontologist should be called to check the site and look for any possible fossils. The palaeontologist must obtain a relevant SAHRA permit in order to collect the fossils (See section 8, Appendix A).

7. References

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. 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 461 – 499.

Modesto, S., 2010. The postcranial skeleton of the aquatic parareptile Mesosaurus tenuidens from the Gondwanan Permian, Journal of Vertebrate Paleontology, 30:5, 1378-1395, DOI: 10.1080/02724634.2010.501443

Oelofson, B.W., Araujo, D. 1987. Mesosaurus tenuidens and Stereosternum tumidum from the Permian of Gondwana of both southern Africa and South America. South African Journal of Science 83, 370-372.

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

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

8. Chance Find Protocol

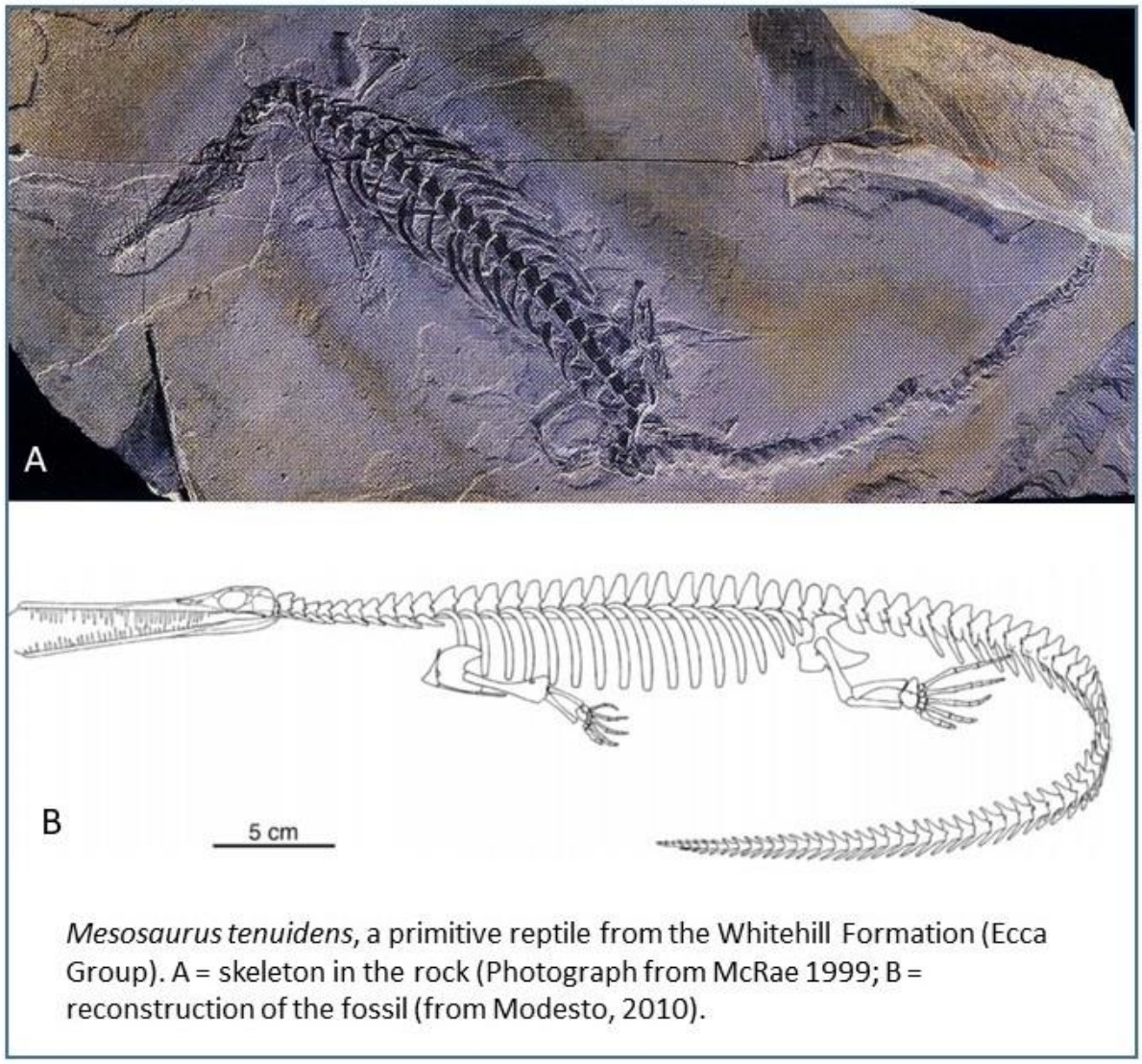
Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

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 must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 5, 6). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.

5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Ecca Group

Figure 5: Examples of trace fossils from the Tierberg and Whitehill Formations (Ecca Group).



Mesosaurus tenuidens, a primitive reptile from the Whitehill Formation (Ecca Group). A = skeleton in the rock (Photograph from McRae 1999; B = reconstruction of the fossil (from Modesto, 2010).

Figure 6: Fossil and reconstruction of a vertebrate fossil.

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.

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)