Palaeontological Impact Assessment for the proposed cemetery (two options) for Dannhauser, KwaZulu-Natal Province

Desktop Study (Phase 1)

For

JLB Consulting

04 May 2021

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

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 JLB Consulting, Durban, 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 development of a Cemetery for Dannhauser and Durnacol, KwaZulu Natal. The local Municipality has proposed two options: Option 1 to the southeast of Dannhauser on Farm Try Again (owned by the Municipality), and Option 2 to the southwest of Dannhauser, close to Durnacol, on land owned by EXXARO.

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 of a cemetery.

The proposed site for Option 1 (Farm Try Again) lies on the shales of the Vryheid Formation and on Jurassic dolerite. Option 2 (EXXARO land) lies on the sandstones and shales of the Volksrust Formation. Only the Vryheid Formation is potentially very highly sensitive as far as the palaeontology is concerned (Glossopteris flora), however, in this region the coal seams are on average more than 80m below surface and are overlain by extensive dolerite sills, the Ngogo, B, and Zuinguin Sills, as well as sandstones. Vryheid Formation shales and coal seams are far below the surface. Since cemetery excavations do not normally exceed 2-3m depth, it is very unlikely that fossils would be encountered or disturbed. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless fossils are found once excavations for infrastructure commence.

Table of Contents

1. Background

The Dannhauser Local Municipality requires to establish a new cemetery of about 10ha to serve the communities of that town and Durnacol. They have two options to consider (Figure 1). Option 1 is to the southeast of Dannhauser on Farm Try Again (owned by the Municipality; Figure 2), and Option 2 to the southwest of Dannhauser, close to Durnacol, on land owned by EXXARO.

A Palaeontological Impact Assessment was requested for the Dannhauser Cemetery 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 presented herein.

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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4

k	Any mitigation measures for inclusion in the EMPr	Section 7, 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 7, 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

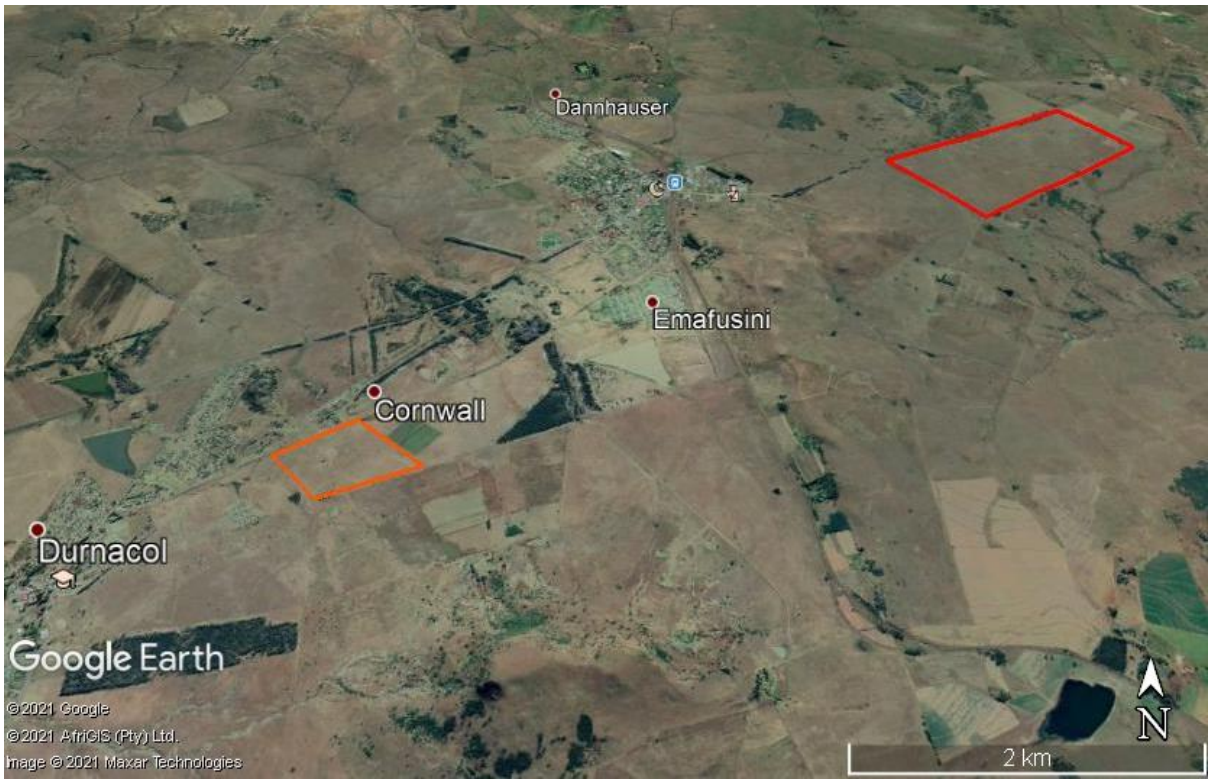

Figure 1: Google Earth map of the two options proposed for a 10 ha Cemetery for Dannhauser. Option 1 (red outline) is on Farm Try Again, and Option 2 (orange outline) is on EXXARO land. Map supplied by JLB Consulting.

Figure 2: Google Earth Map for Option 1 (Farm Try Again).

Figure 3: Google Earth map for Option 2 (EXXARO land near Durnacol).

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

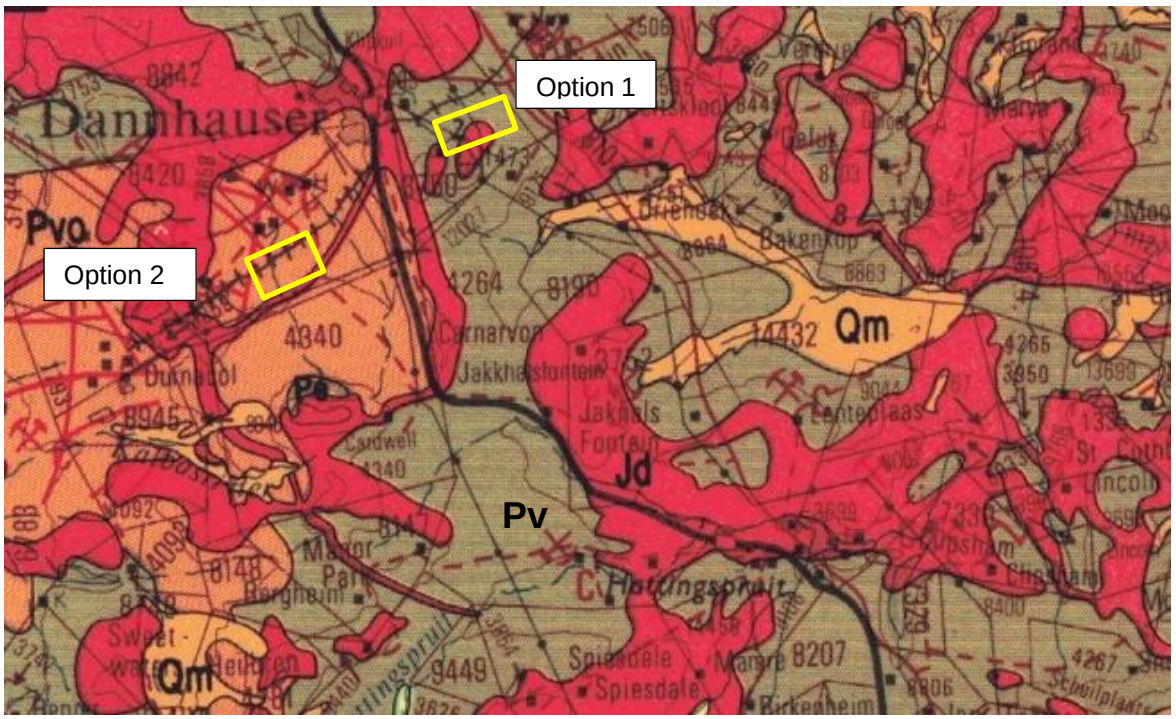

Figure 2: Geological map of the area around Dannhauser and Durnacol with the two options for the cemetery as indicated. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2830 Dundee.

Table 2: Explanation of symbols for the geological map and approximate ages (Botha and Federoc, 1995; Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; ka = thousand years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qm	Masotcheni Fm.	Colluvium palaeosols, sand, calcrete	Pleistocene, last 120 ka to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pvo	Volksrust Fm, Ecca Group, Karoo SG	Mudstones, shales, sandstones	Middle Permian, late Ecca
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca

Dannhauser is in the east central part of the Karoo Basin where Ecca Group strata are well-represented. To the south are extensive outcrops of intrusive dolerite dykes, and in this area, the Klip River Coal field, there are three dolerite sills that have intruded through the Karoo Supergroup sediments (Figure 4). Overlying part of the area are the recent colluvium and paleosols of the Masotcheni Formation of Pleistocene age.

The huge inland Karoo Basin is filled with rocks of the Karoo Supergroup. At the base is the Dwyka Group composed of tillites and diamictites deposited by the receding glaciers during the Upper Carboniferous to Early Permian.

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. In the Free State and KwaZulu Natal, from the base upwards are the Pietermaritzburg Formation, Vryheid Formation and the Volksrust 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 rocks are the Beaufort Group Rocks that are late Permian and early Triassic in age. There are six formations in the Beaufort Group but their distribution is not the same throughout the basin. The next group is the Stormberg Group (Molteno, Elliot and Clarens Formations) with the final Drakensberg Formation basalts capping the strata and representing the end of Karoo sedimentation.

The Ecca Group in the Free State and KwaZulu Natal contains major coal deposits in the form of horizontal seams laid down on the uneven Dwyka topography, interspersed with shales and sandstones, and interrupted by Jurassic aged dykes and sills (associated with the basalt outpouring that occurred when Gondwana began to separate (Drakensberg Formation).

Much younger colluvium and sands overlie large parts of KwaZulu Natal and are Quaternary in age. Here they are called the Masotcheni Formation and have been dated to 120 ka (Botha and Federov, 1995; Partridge et al., 2006).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 5 and 6. Option 1 is on potentially very highly sensitive strata of the Vryheid Formation (Ecca Group, Karoo Supergroup). Only fossil plants are known from this formation and comprise the Glossopteris flora, namely Glossopteris leaves, seeds and reproductive organs, lycopods, sphenophytes, ferns and early gymnosperms (Plumstead, 1989; Anderson and Anderson, 1985; Bamford, 2004). Occasionally insect wings occur with the plants. No vertebrates are known. Dolerite is an intrusive volcanic rock and does not preserve fossils.

The overlying Volksrust Formation is present in the location of Option 2 (Figure 6). Only very rare fragments of Glossopteris flora plants are known from this formation because it represents deeper water environments; coal seams are absent from this formation.

Masotcheni Formation colluvium does not preserve fossils because it is transported and very young (Botha and Federov, 1995; Partridge et al., 2006).

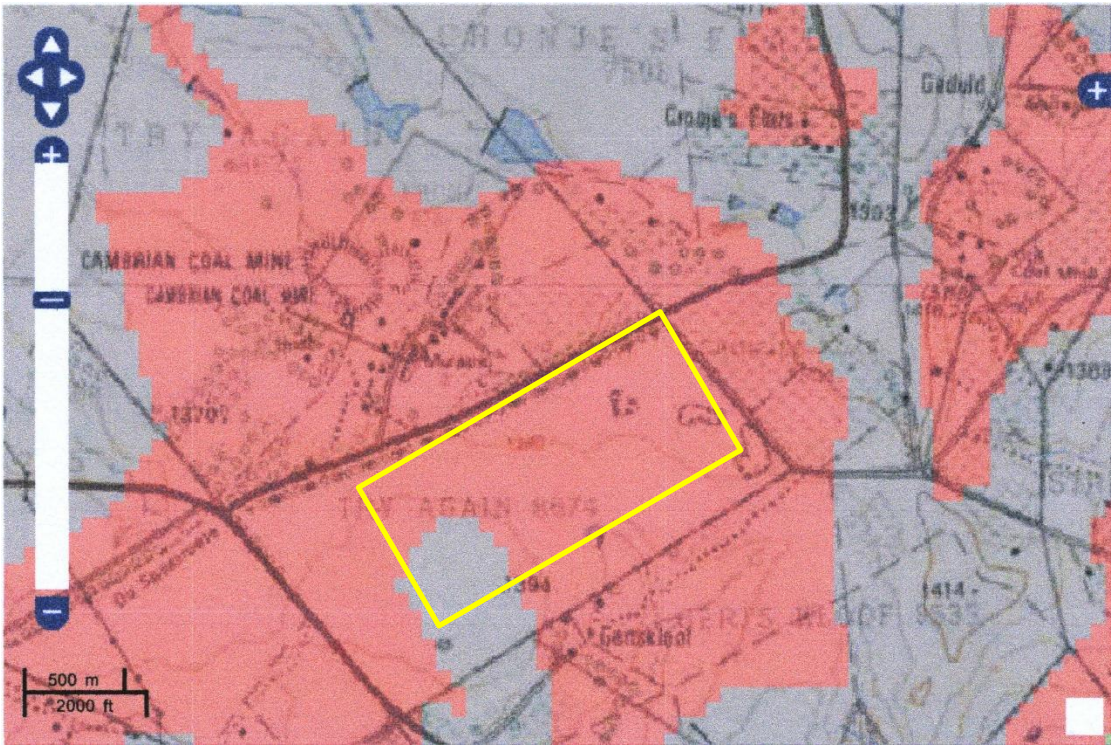

Figure 5: SAHRIS palaeosensitivity map for the site for Option 1 (Try Again Farm) for the proposed cemetery for Dannhauser shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

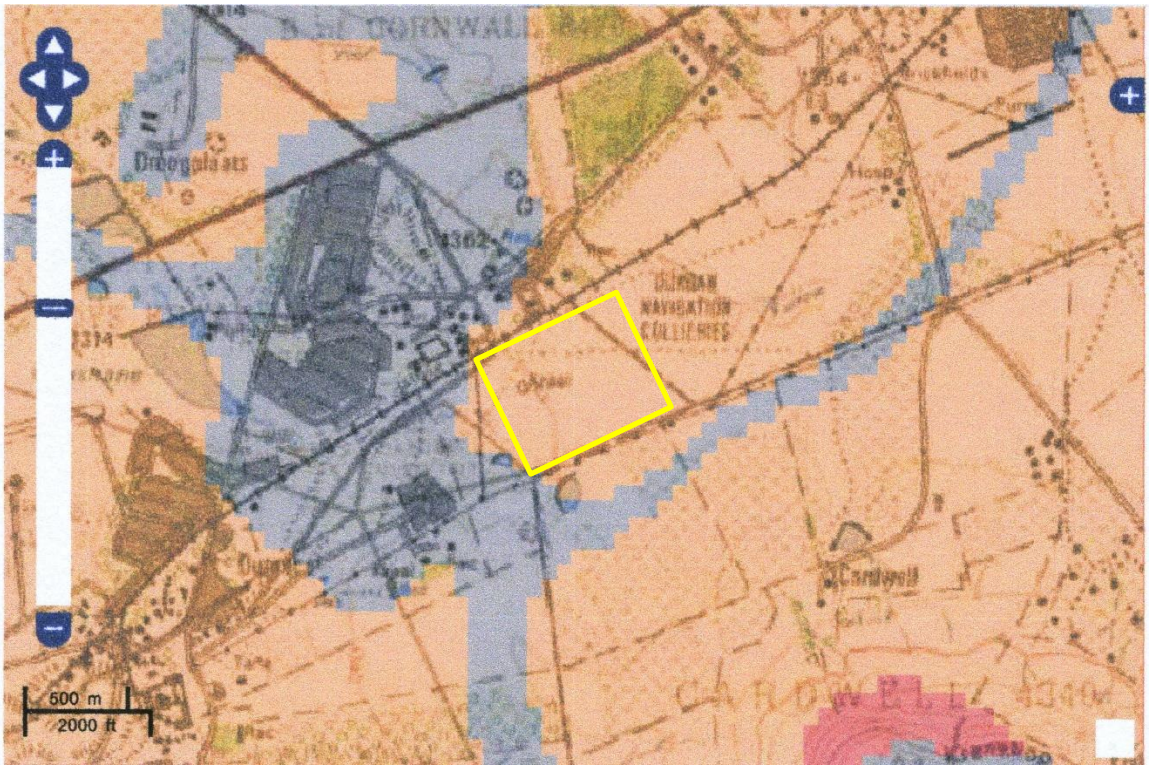

Figure 6: SAHRIS palaeosensitivity map for the site for Option 2 (EXXARO land, northeast of Durnacol and southwest of Dannhauser) for the proposed cemetery for Dannhauser shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero

From the SAHRIS map above the area for Option 1 is indicated as very highly sensitive (red) because the Vryheid Formation in other coalfields and regions preserves fossil plant impressions. The Klip River Coalfield, however, is unusual in that there are three extensive dolerite sills (A sill is horizontal dolerite that does not reach the surface; dykes are vertical to oblique and the molten material does reach the surface. Dolerite sills and dykes are intrusions of igneous rock formed by molten magma from the Earth's mantle that forced its way to the surface through cracks in the rock layers. Cracks may form when there is tension in the Earth's surface, e.g. the break-up of Gondwanaland). Dolerite, in both sill and dyke forms, destroys any fossil material in its vicinity. According to Snyman (1998) the uppermost seams in the Klip River Coalfield are 60m or more below the ground surface and are overlain by sandstone layers and one of the dolerite sills (Ngogo, B or Zuinguin). Fossil plants originally formed the peats that were buried and transformed by heat and pressure to form coal seams, but no plant matter is visible in coal. Only fine-grained material such as shales between coal seams would preserve any plant matter; sandstones and dolerite do not. Therefore, any fossil plant material in the Vryheid Formation would be more than 10m below the ground surface.

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	Dolerite and coarse sandstones do not preserve plant fossils; so far there are no records from the Vryheid Formation of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. Fossils may occur 10m or more below the ground surface. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be fossil plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: ASSESSMENT		
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the soils, dolerite sills or sandstones that overlie the coal seams and associated shales. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities are unlikely to impact upon the fossil heritage of the Vryheid Formation that might be preserved below ground within the development footprint (Option 1). The Volksrust Formation is unlikely to preserve any recognisable fossil plants (Option 2). Since there is an extremely small chance that fossils from the Vryheid Formation shales that are more than 10m below ground, 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 only the shales are likely to contain fossil plant, insect and invertebrate. The colluvium of the Quaternary period would not preserve fossils. Cores from nearby collieries indicate that the uppermost shales are more than 10m below the surface so excavations for infrastructure, amenities and graves to a depth of 2-3m are unikely to intersect any fossil material.

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 Volksrust Formation (Option 2). There is a very small chance that fossils may occur in the adjacent shales of the early Permian Vryheid Formation but well below the surface (Option 1), so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Bamford, M.K., 2004. Diversity of the woody vegetation of Gondwanan southern Africa. Gondwana Research 7, 153-164.

Botha, G.A., Federov, N., 1995. Palaeosols in Late Quaternary colluvium, northern KwaZulu-Natal, South Africa. Journal of African Earth Sciences 21, 291-311.

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.

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.

Snyman, C.P., 1998. Coal. In: Wilson, M.G.C., and Anhaeusser, C.P., (Eds). The Mineral Resources of South Africa: Handbook, Council for Geosciences 16, 136-205.

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 (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 7). 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/miners 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 Vryheid Formation

Figure 7: Fossil plant impressions of the Glossopteris flora from the Vryheid Formation (Ecca Group, Karoo Supergroup).

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	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

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 = 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)