Appendix C: Palaeontological Impact Assessment

Palaeontological Impact Assessment for the proposed development of a SEZ, Musina-Makhado Limpopo Province

Phase 2/Site Report

For

Digby Wells Environmental
LEA5514

26 March 2019

Prof Marion Bamford
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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 23 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Digby Wells, 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 Phase 2 or site visit Palaeontological Impact Assessment was requested for the proposed development of a Special Economic Zone (SEZ), energy and metallurgy, between Musina and Makhado, Limpopo 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 site visit Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The site visit from 14-16 March 2019 to survey the very highly sensitive palaeontological areas (Farms Dreyer 526 and Van der Bijl 528) as well as a representative section of the moderately sensitive areas that will be affected by the new infrastructure, was completed and yielded no fossils at all. The narrow bands of Karoo Supergroup sediments, namely the basal Tshidzi, Madzaringwe and Mikambeni Formations, could potentially contain fossil plants of the very early *Glossopteris* flora in the shales and mudstones. The Molteno equivalent Fripps Formation will not be in the development footprint. No fossils were found on any of the sites visited. Since there is still a small chance that fossils could occur below the surface a Fossil Chance Find Protocol should be added to the EMPr for when excavations commence.

Table of Contents

1. Background

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 site visit was carried out and is reported here.

Project background and description:
Limpopo Economic Development Agency (LEDA) has appointed Digby Wells Environmental to undertake an environmental assessment as part of the Scoping and Environmental Impact Reporting process for the Musina-Makhado Energy and Metallurgy SEZ.

The proposed Musina-Makhado SEZ is located across the Musina and Makhado local municipalities which fall under the Vhembe District Municipality in the Limpopo Province. The nearest town is Makhado (located 31 km south) and Musina (located 36 km north) of the proposed SEZ site. The Musina-Makhado SEZ development will be established across eight farms, refer to the table and figure below. The total farm area adds up to approximately 8000 hectares of which 6000 hectares will be used for the SEZ.

Table 1: Properties for the establishment of the Musina-Makhado SEZ

FARM NAME	PARCEL NO	PORTION	LONGITUDE	LATITUDE	AREA (HA)
Dreyer	256	0	29°53'32.293" E	22°37'41.220" S	1310
Joffre	584	1	29°52'34.911" E	22°43'40.691" S	632
Antrobus	566	0	29°54'30.119" E	22°39'14.963" S	975
Battle	585	0	29°52'5.264" E	22°42'24.788" S	751
Steenbok	565	0	29°52'47.745" E	22°39'56.700" S	990
Van der Bijl	528	0	29°51'16.770" E	22°38'50.852" S	1509
Lekkerlag	580	0	29°53'55.558" E	22°42'58.950" S	892
Somme	611	0	29°53'44.488" E	22°41'23.727"	989
				Total area	**8048**

A site visit was undertaken between 14-16 March 2019 by Frederick Tolchard, who is working with Prof Bamford, to visit the site and inspect the areas that will be impacted by the project (see section 3iii) and the results are presented here.

Table 2: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B

A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section **Error! Reference source not found.** **Error! Reference source not found.**
An identification of any areas to be avoided, including buffers	N/A
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
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
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
Any mitigation measures for inclusion in the EMPr	N/A
Any conditions for inclusion in the environmental authorisation	N/A
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
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
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

Figure 1: Google Earth map of the proposed area to be developed for the Musina-Makhado SEZ project. Map supplied by Delta.

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 (*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

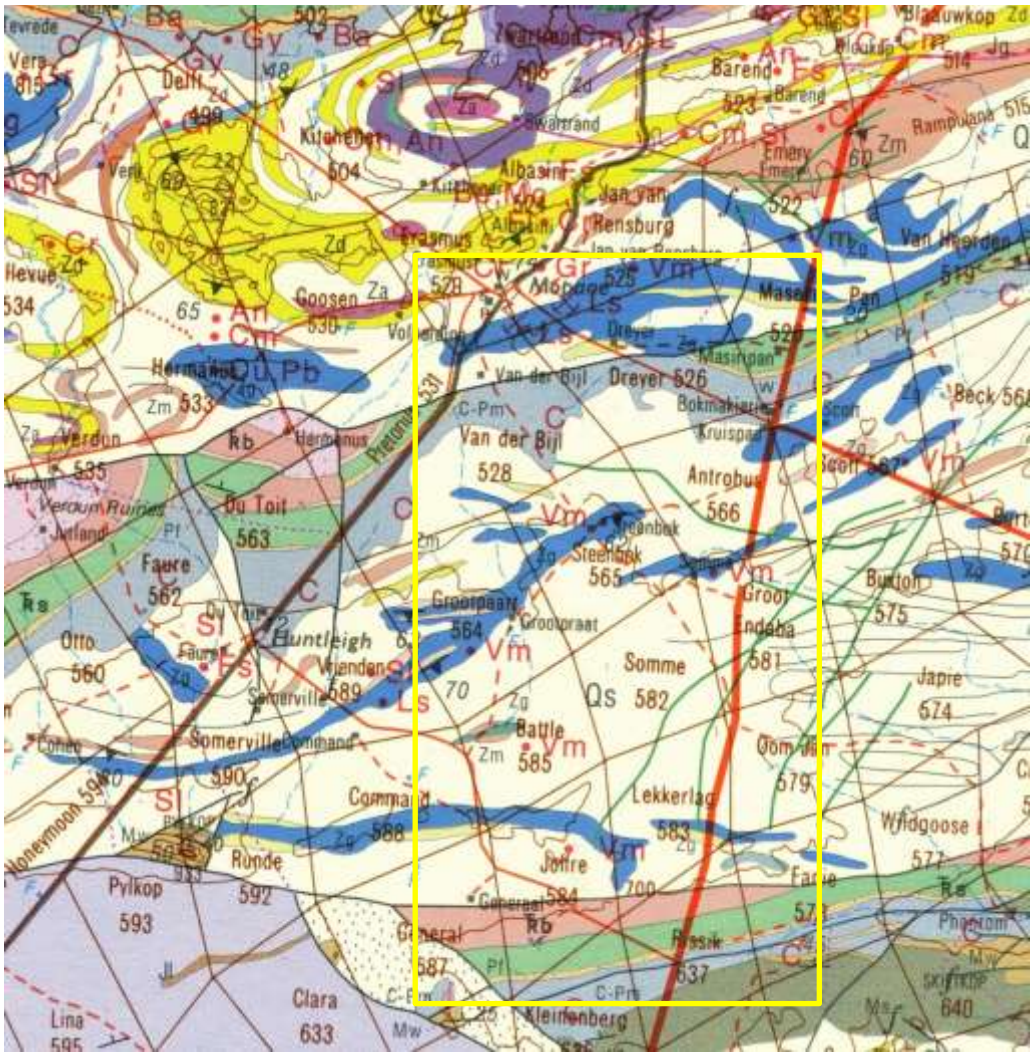

Figure 2: Geological map of the area between Musina and Makhado (Louis Trichardt) Limpopo Province. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2228 Alldays, 2000.

Table 3: Explanation of symbols for the geological map and approximate ages (Kramers et al., 2006. Johnson et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary	Soils, sand, silcrete	Last 2.6 Ma
Tr cr	Clarens Fm	Red argillaceous sandstone and cream sandstone	Late Triassic

Symbol	Group/Formation	Lithology	Approximate Age
Trb	Bosbokpoort Fm, Tuli trough, Karoo SG	Red mudstone to fine sandstone	Late Triassic
Trs	Solitude Fm	Siltstones, sandstones, purple mudstones and grey shales	Late Triassic
Pf	Fripp Fm	Sandstone and grit	Molteno Fm; Carnian-Norian late Triassic
C-Pm	Mikambeni Fm	Mudstones, shales, laminated sanstones	Ecca equivalent; Permian
C-Pm	Madzaringwe Fm	Feldspathic sandstone, coal	Ecca Equivalent; Permian
C-Pm	Tshidzi Fm	Diamictite in argillaceous matrix, sandstones	Ecca equivalent; Permian
Zm	Malala Drift Suite, Beitbridge Complex	Gneiss, quartzites, marble, metapellites, banded iron stone	Ca 2610 Ma
Zg	Gumbu Group, Beitbridge Complex	Gneiss, quartzites, marble, metapellites, banded iron stone	Ca 2640 Ma
Zd	Mt Dowe Group, Beitbridge Complex	Gneiss, quartzites, marble, metapellites, banded iron stone	Ca 2640 Ma

The location of the project lies on the Limpopo Belt which runs more or less east-west, and the central section is overlain by much younger sediments of the Tuli Basin, Karoo Supergroup. There is also a covering of Quaternary sands (Fig 3).

There are outcrops of the Beitbridge Complex in the central part of the project area. These ancient gneisses, quartzites and banded iron formation have been metamorphosed. They are over 2600 million years old (Kramers et al., 2006).

The Tuli Basin has been fragmented by faulting and is most probably only a remnant of a much more extensive setting. Only narrow bands of these sediments are present today in the area. The oldest Karoo sediments in this Basin, the Tshidzi Formation, comprise diamictites and interbedded sandstone, probably representing glacial and fluvio-glacial environments (Johnson et al., 2006) Madzaringwe and Mikambeni Formations are composed of various sandstones and might be equivalent of the Ecca Group Vryheid Formation. The Fripp Formation is composed of well-sorted, medium to coarse-grained white arkosic sandstone and might represent point-bar and channel –lag deposits (Johnson et a., 2006). Overlying this are finer-grained sediments, namely siltstones, fine sandstones and mudstones of the Solitude Formation that are typical of distal floodplain overbank and crevasse=splay deposits, i.e. an environment associated with mature meandering streams (Johnson et al., 2006). Red to purple mudstones with minor white siltstone layers and rare infraformational conglomerates are indicative of the Bosbokpoort Formation. These were deposited in a low energy floodplain of mature meandering streams (Johnson et al., 2006).

The Clarens Formation in the Tuli Basin (as in the adjacent Tshipise Basin) can be divided into an upper and a lower section, the lower Red Rocks Member and the upper Tshipise Member. As the name implies the Red Rocks Member is composed of reddish sands deposited in a dry climate, and calcareous nodules. The Tshipise Member sandstones were also laid down in arid conditions and are made up of Aeolian sands (Johnson et al., 2006).

A widespread covering of Quaternary soils and sands is present in much of the project area.

ii. Palaeontological context

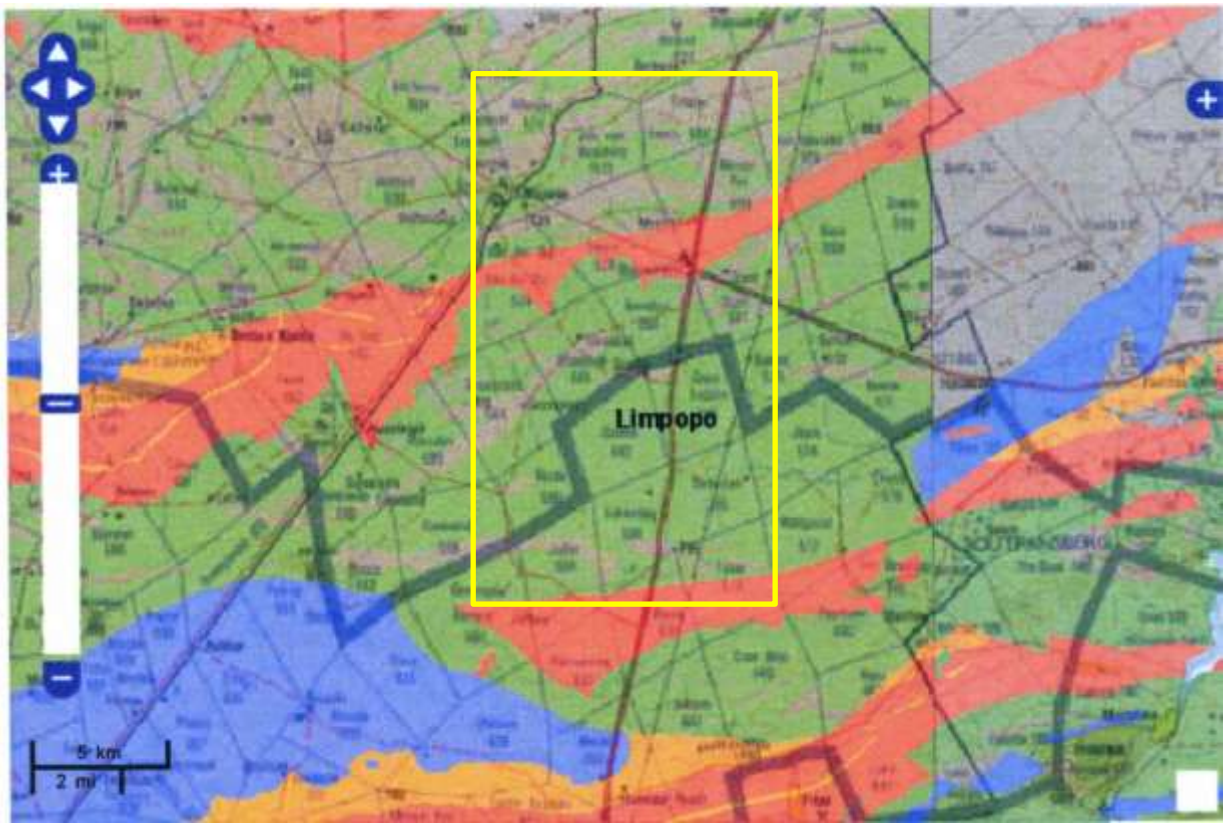

Figure 3: SAHRIS palaeosensitivity map for the Musina-Makhado SEZ project, Limpopo Province. The site surveyed is within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The Beitbridge Complex rocks are ancient: they predate any body fossils. Furthermore, they have been metamorphosed and so would not preserve any fossils, even if they had been present. The Quaternary soils also would not preserve any fossils because soils are complex "rocks" comprising weathered material and organic matter.

In contrast, the rocks of the Karoo Supergroup, could preserve fossils as they have been reported from the main Karoo Basin. The basal Tshidzi, Madzaringwe and Mikambeni

Formations are reportedly of Carboniferous to early Permian age so too old for vertebrate fossils (except the rare *Mesosaurus*) but thin coal seams have been reported (Johnson et al., 2006). The plants associated with the coals would be from the *Glossopteris* flora. The overlying Karoo Supergroup strata could contain fossil plants and vertebrates but the dating based on the fossils is very confusing and not well substantiated. For example, the Fripp Formation in the Tshipise Basin purportedly has the fossil plant *Dicroidium* but this is a Molteno taxon (recently revised by Anderson et al., 2019), yet there are several strata above that are also considered to be Late Triassic. The fossil record from this region needs to be re-assessed.

The palaeontological sensitivity of the area under consideration is presented in Figures 3. Because there is some confusion about the presence and age of the fossils reported a site visit is considered necessary.

iii. Site Visit

The Musina-Makhado SEZ farm properties were visited on 14-16 March 2019, focussing on the sites that are indicated as very highly sensitive on the SAHRS palaeosensitivity map (Fig 3) and where sediments were visible.

Table 4: List of sites visited with the latitude and longitude provided, observations and related figure for photographs of the site.

Site designation	GPS co-ords	Comment
Dreyer1:	S 22°37.447' E 29°54.836' 605m	Sediments dominantly red, fine-grained and with pebbles and other clasts; no fossils Figure 4
Dreyer2:	S22°37.451' E29°54.836' 619m	Same as above (no figure)
Dreyer3:	S22°37.073' E29°52.927' 670m	Same as above but coarser grained sands and some pebbles weathering out. Figure 5
Dreyer4:	S 22°38.380' E 29°54.507' 681m	Reddish sands and mudstones (no figure)
Vanderbijl1:	S 22°37.440' E 29°51.741' 723m	Grey to whitish rocks and weathering of the rocks. No fossils. Figure 6
Vanderbijl2:	S 22°37.552' E 29°51.432'	AS above, with larger pieces breaking off. No fossils (no figure)

	685m	
Vanderbijl3:	S 22°40.246' E 29°49.635' 685m	As above (no figure)
Antrobus2	S 22°39.417' E 29°53.995' 670m	Grey shales exposed in the shallow stream cutting. The stream was followed for more than 50m but no fossils were found. Figure 7
Battle1	S 22°43.402' E 29°51.747' 725m	No fossils on the flat surface, nor in the steep cutting that revealed layered shales. Figure 8
Lekkerlag1	S 22°42.447' E 29°54.347' 737m	Denser vegetation along the streams, sandstones and shales present but no fossils Figure 9

Figure 4: Photograph of rocks and sediments on Farm Dreyer 526 – gneiss, red sands and soil but no fossils preserved.

Figure 5: Farm Dreyer 526. Red sands and mudstones with pebbles weathering out. No fossils.

Figure 6: Farm Van der Bijl 528 – grey to whitish weathered rocks and coarse, angular fraction from weathering..

Figure 7: Farm. Antrobus 566 – non-fossiliferous shales exposed in a natural stream cutting.

Figure 8: Farm Battle 585 – steep cutting revealing shales but no fossils found.

Figure 9: Farm Lekkerlag 580 – fairly dense vegetation along the streams, sandstones weathering out but no fossils.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 5:

TABLE 5A: 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 5B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	The Tshidzi, Madzaringwe and Mikambeni Fms could contain late Carboniferous to early Permian plants of the very early *Glossopteris* flora. The impact would be moderate
	L	..
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be fossil plants from the *Glossopteris* flora or the *Dicroidium* (Molteno) flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**There is a moderate chance of fossils occurring BUT none was found during the survey. There is a small chance that once excavations begin fossils will be exposed from below the surface or associated with the mudstones or the shale lenses between the coal seams, so a Chance Find Protocol should be added to the 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 correct age and type to preserve fossils, however none was found by the palaeontologist who surveyed the area. The Fripp and Solitude Formations are not within the footprint. Since there is a small chance that fossils from the Tshidsi, Madzaringwe and Mikambeni Formations in the central sections of the farms Dreyer 256 and Van der Bijl 258, may be found below the surface and therefore will be disturbed, a Fossil Chance Find Protocol has been added to this report. It is extremely unlikely that fossils will occur on the rest of the farms within the project area. Taking account of the defined criteria and results of the survey, 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 plants of the early Permian *Glossopteris* flora. From the survey we are certain that there are no surface exposures of fossils because there are deep soils. They may occur below ground but from the onsite survey carried out there were NO fossils exposed. If they are present then they are extremely rare and sporadic.

6. Recommendation

Based on experience and the lack of any fossils recorded previously or found during the site visit to the area, it is unlikely that many fossils would be preserved in the site. Nonetheless, there is a very small chance that fossils may occur below the surface 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 with the relevant SAHRA permit.

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.

Anderson, H.M., Barbacka, M.K., Bamford, M.K., Holmes, W.B.K., Anderson, J.M., 2019. *Umkomasia* (megasporophyll): part 1 of a reassessment of Gondwana Triassic plant genera and a reclassification of some previously attributed, Alcheringa: An Australasian Journal of Palaeontology 43, 43-70. DOI: 10.1080/03115518.2018.1554748

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.

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.

Kramers, J.D., McCourt, S., van Reenen, D.D., 2006. The Limpopo Belt. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 209-236.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations for infrastructure begin.

1. The following procedure is only required if fossils are seen on the surface and when 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) 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 8, 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 possible fossil material found by the developer or 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 the site inspections by the palaeontologist will not be necessary. Annual reports by the palaeontologist must be sent to SAHRA.
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

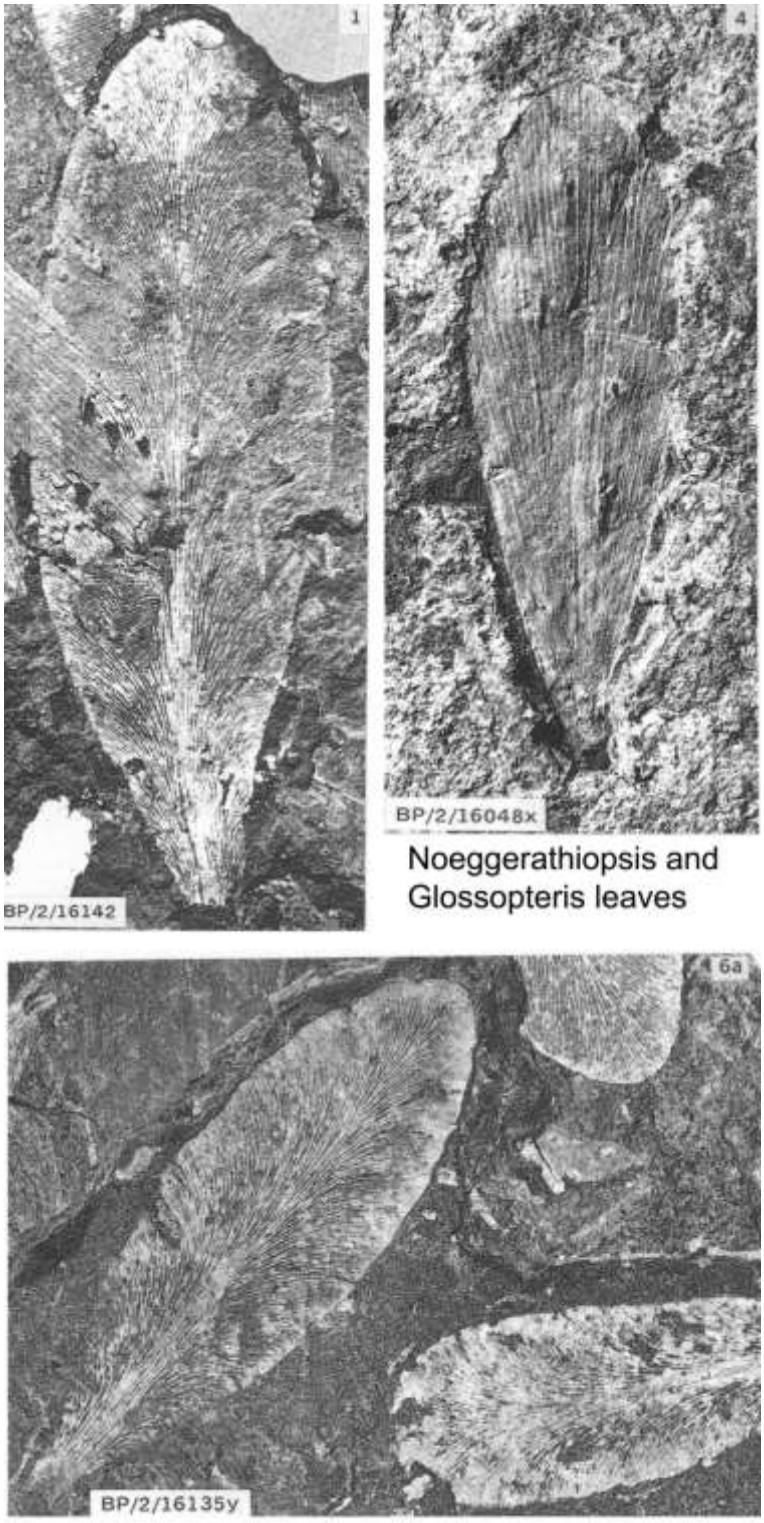

Figure 9: *Glossopteris* and cordaitalean leaves from Ecca sediments

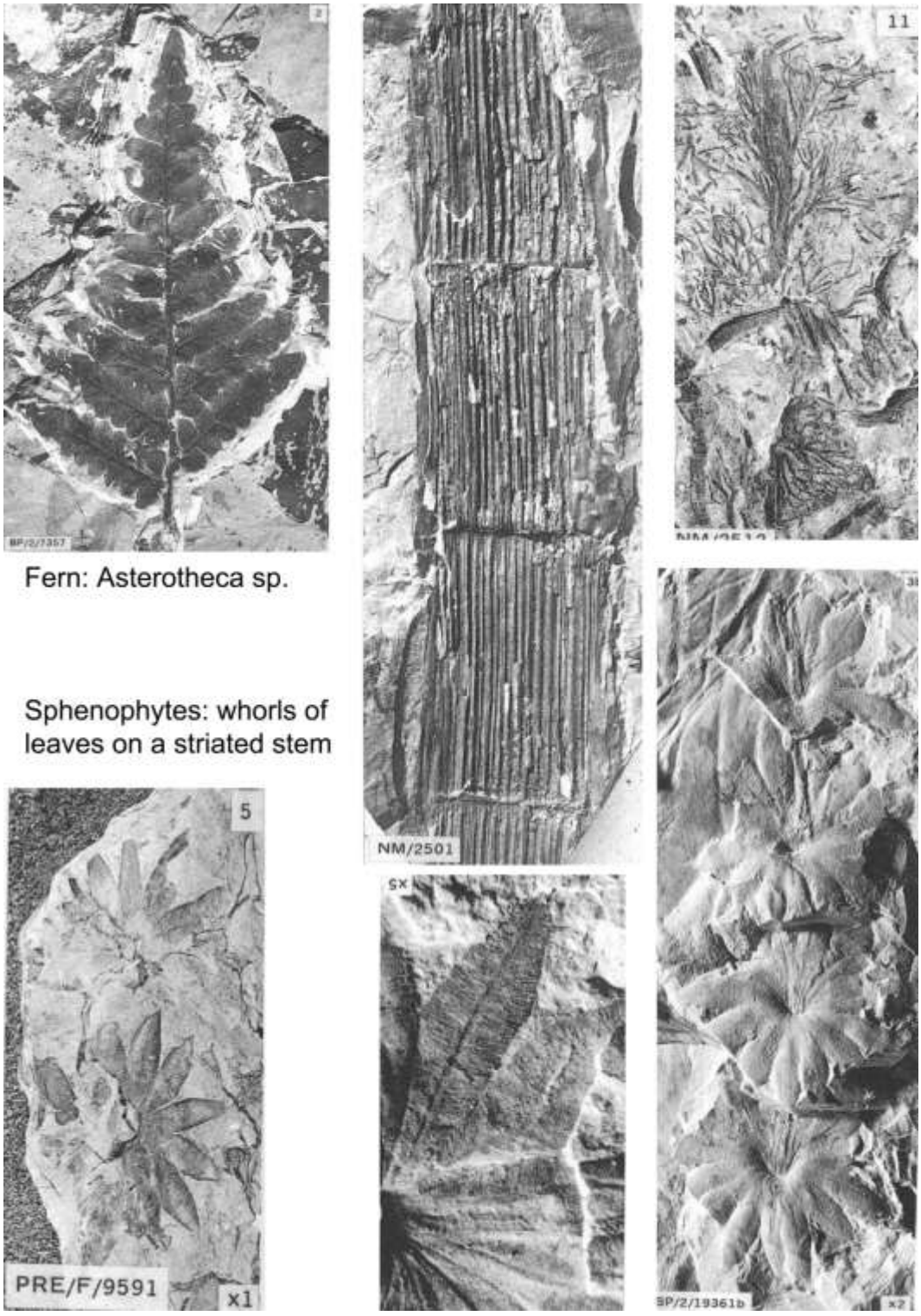

Figure 10: other examples from the *Glossopteris* flora – sphenophytes that are known to occur in other Vryheid Formation localities.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2019

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	6	1
Masters	8	1
PhD	10	3
Postdoctoral fellows	9	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 –
Cretaceous Research: 2014 -

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
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xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 125 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 26; Google scholar h index = 30;
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)