

**Palaeontological Impact Assessment for the proposed
Kwasobabili Cooperative (irrigation project), near
Estcourt, KwaZulu Natal Province**

Desktop Study

For

GCS Water and Environmental (Pty) Ltd

21 January 2018

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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; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by GCS Water and Environmental, Kloof, 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

To comply 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 an irrigation scheme at Kwasobabili (or Sobabili) Cooperative, near Estcourt, KwaZulu Natal Province.

The proposed site lies on the shales of the Adelaide and Estcourt Subgroups of the Beaufort Group, upper Permian and could possibly contain fossil plant material in particular, but also fossil insects, invertebrates, fish or vertebrates. Fossil plants of the *Glossopteris* flora have been recorded from at least 25 localities in the Estcourt Formation in this region, but not from the site to be developed. The Tarkastad Subgroup is in close proximity and may underlie parts of the site; it is of Early Permian age and could contain vertebrate fossils or plant fossils of the *Dicroidium* flora. Based on this information it is recommended that a phase 2 or site visit be conducted.

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1. Background

The National Department of Rural Development and Land Reform (DRDLR) has identified six Irrigation Projects from their Clustering of Rural Enterprise and Industrial Development (REID) Projects for Phase Two to be implemented on behalf of various agricultural cooperatives in various District Municipalities in Kwazulu-Natal. This Consultation Basic Assessment Report (CBAR) relates to the proposed Sobabili Agricultural Cooperative irrigation project.

The proposed site is located on Portion 1 of Drakensburg Location No. 1 No. 9604, within the Imbabazane Local Municipality of KwaZulu-Natal, near the town of Estcourt. The proposed irrigation project involves the abstraction of water from the Klein-Boesmans River through the installation of a seepage well along the Klein-Boesmans River, with a capacity of 100m³/h, for irrigation purposes. The proposed site, known as “Kwasobabili” is approximately 10.2 hectares in size and is located on Portion 1 of Drakensburg Location No. 1 No. 9604 in the Imbabazane Local Municipality of KwaZulu-Natal (NOFS0000000960400001). The centre point of the site is located at S 29° 03' 46.9"; E 29° 40' 47.4" (Figure 1). A desktop palaeontological impact assessment is presented here.

Table 1: 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 ii 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	n/a
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

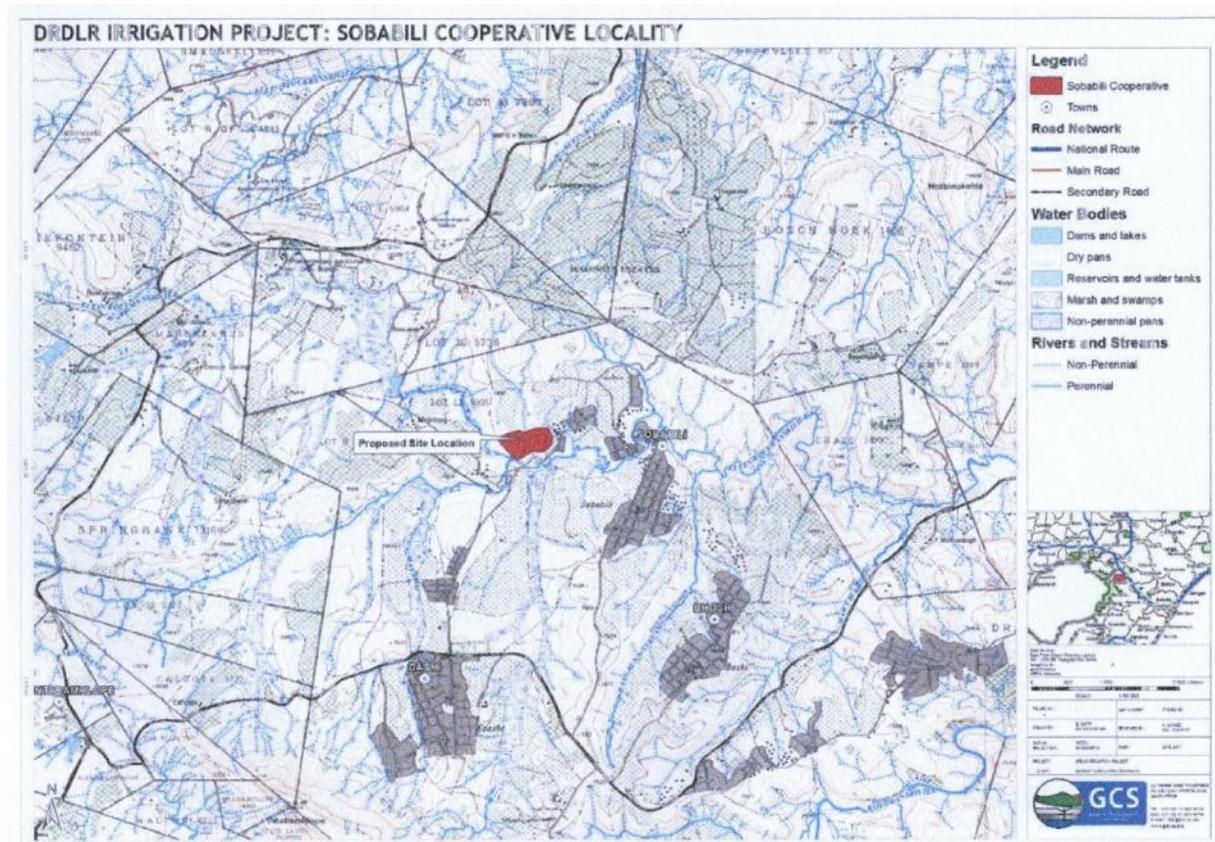


Figure 1: Detailed map of the proposed position for the Kwasobabili Cooperative irrigation project (red). Map supplied by GCS.

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 representativity 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 project area for the proposed irrigation scheme at Kwasobabili Cooperative on Portion 1 of Drakensburg Location No. 1 No. 9604 in the Imbabazane Local Municipality, lies on sediments and shales of the Adelaide and Estcourt Subgroups of the Beaufort Group or on sediments of the Tarkastad Subgroup. The Drakensberg mountains are to the west of the site. Kwasobabili is on the northwest margin of the main Karoo basin in KwaZulu Natal. Dolerite dykes are rare in this region. To the east are sediments of the Volksrust Formation and coal deposits of the Vryheid Formation.

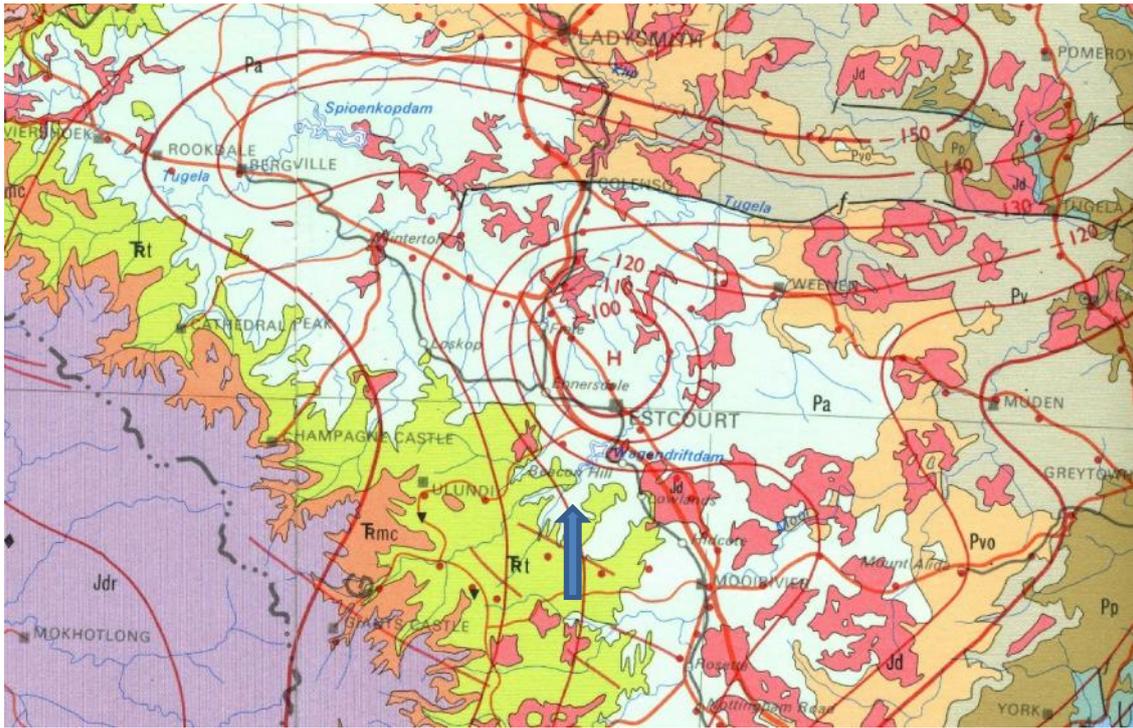


Figure 1: Geological map of the area around Estcourt. The site of interest, Kwasobabili Cooperative, is to the southwest of Estcourt and the location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Erikssen et al., 2006. Johnson et al., 2006). SG = Supergroup; Fm = Formation.

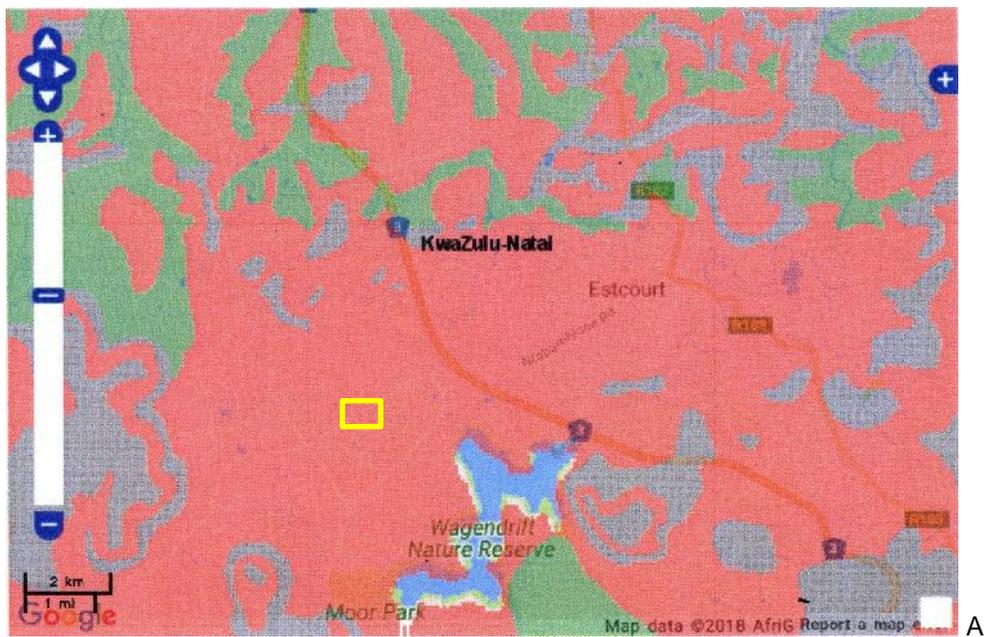
Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Trt	Tarkastad Subgroup, Beaufort Group	Shale, sandstone, mudstone, coal	Early Triassic 252 – 230 Ma
Pa	Adelaide and Estcourt Subgroups	Mudstone, sandstone	Late Permian 270-252 Ma
Pvo	Volkstrust Fm	shale	Middle Permian, Upper Ecca
Pv	Vryheid Fm	Shales, sandstone, coal	Lower Permian, Middle Ecca
C-Pd	Dwyka	Tillite, sandstone, mudstone, shale	Upper Carboniferous, Early Permian 295-290 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3a.b. The site for development is in the Adelaide Subgroup and/or the Tarkastad Subgroup which is slightly younger than the Adelaide Subgroup. In this part of the Karoo Basin, KwaZulu-Natal, the Adelaide Subgroup consists primarily of a lower deltaic facies, mostly referred to as the

Estcourt Formation and an upper fluvial facies referred to as the Normandien Formation (Groenewald, 1984; Johnson et al., 2006). These two formations are not separated in the map. Fossils are fairly common in the Adelaide subgroup and comprise vertebrates, fish, insect, invertebrates and their burrows and trails, silicified wood and leaf impressions of the *Glossopteris* flora (list in appendix A).

The Tarkstad Subgroup is Early Triassic and comprises a greater abundance of sandstone and red mudstone than the upper Permian Adelaide Subgroup. In KwaZulu Natal the former is made up of two formations, the lower or older Verkykerskop Formation (fine to very coarse-grained sandstone) and overlying (younger) Driekoppen Formation (mudstone) (Groenewald, 1989; Johnson et al., 2006). They are equivalent in age to the Burgersdorp Formation which outcrops in the southern part of the Karoo Basin.



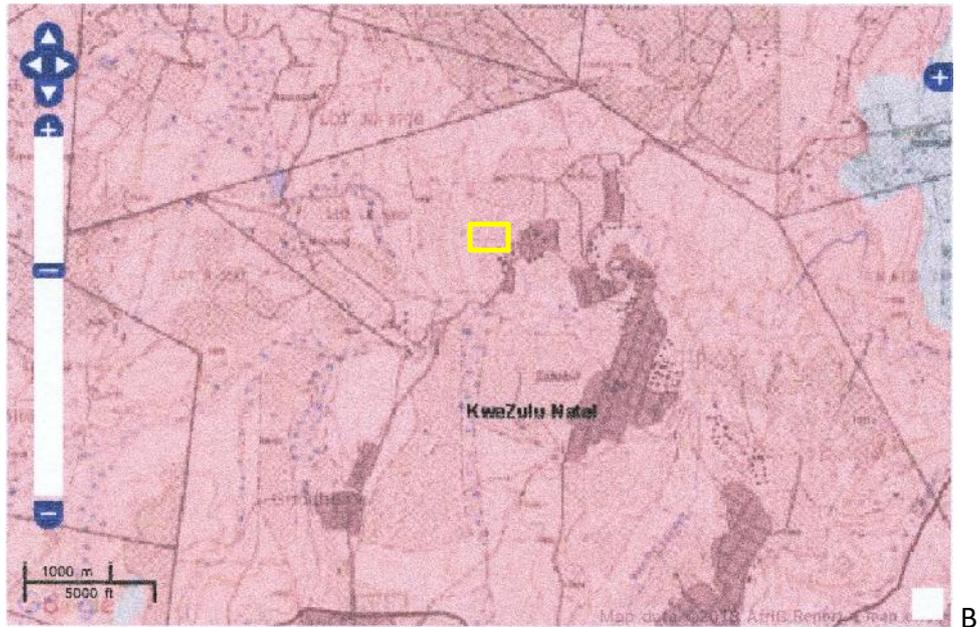


Figure 3: SAHRIS palaeosensitivity maps for the region (3a) and in detail (3b). The proposed Kwasobabili Cooperative irrigation project is shown within the yellow rectangular outline. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Heidi and John Anderson collected Estcourt Formation plant fossils from 25 localities (Anderson and Anderson, 1985: 32-35) and more recently a group of local and international palaeontologists (Prevec et al., 2009), and later Marco Klaasens, collected plants from the Normandien Formation in KwaZulu Natal. They also collected extensively in the southern Karoo Burgersdorp Formation which contains the *Dicroidium* flora which is distinct from the Glossopteris flora which essentially went extinct at the Permo-Triassic boundary. See list in Appendix A. The vertebrate fauna has been much more extensively studied and mapped in the southern part of the Karoo Basin.

The general study area has been disturbed through previous agricultural activities. There does however remain a small chance that fossil plants may be identified where new excavations are made.

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	.
	L+	-
	M+	Excavation for irrigation pipes, foundations, road access and infrastructure would not penetrate more than a few metres. If fossil plants or vertebrates are present they would be disturbed. The chance of finding fossil plants would be moderate so there would be minor deterioration of the surface of sites and a minor impact on any potential fossils. Therefore the SEVERITY/NATURE of the environmental impact would be moderate
	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 such as leaf impressions and reproductive structures from the <i>Glossopteris</i> flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	There is a chance of finding leaf fossils in the sediments and rocky outcrops as these have been reported from the same formations but not in this particular area. However, the probability of affecting any fossils is unlikely or seldom because the area has been disturbed by agricultural activities. M
	L	

Based on the nature of the project, surface activities may impact on fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are sedimentary and of the correct age for fossil heritage to occur. None has yet been recorded from this site and the general project area is already highly disturbed through agricultural activities and various road works. There is a chance of finding fossils so a phase 2 or site visit is recommended. Taking account of the defined criteria, the potential impact to fossil heritage resources is moderate.

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 coals are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. The shales of the upper Permian Estcourt and Normandien Formations, Adelaide Subgroup, Beaufort Group could contain impression fossils of plants of the *Glossopteris* flora and the Tarkastad Subgroup formations, the Verkykerskop and Driekoppen Formations could contain fossils of the Triassic *Dicrioidium* flora.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is moderately likely that some fossils will be identified in the proposed site for the Isondlo Dairy irrigation project, and for the greater, as indicated in the SAHRIS palaeosensitivity map. As there is a potential for finding fossils, in particular plants, a phase 2 or site visit is recommended. Furthermore, if fossils are found I suggest that representative collection be made, with the relevant AMAFA permit, and housed in a recognised institution (museum or university with a palaeontology department).

7. References

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

Barbolini, N., Bamford, M. K., Rubidge, B., 2016. Radiometric dating demonstrates that Permian spore-pollen zones of Australia and South Africa are diachronous. *Gondwana Research* 37, 241–251.

Groenewald, G.H. 1989. Stratigrafie en sedimentology van die Groep Beaufort in die Noordoos-Vrystaat. *Bulletin of the Geological Survey of South Africa* 96, 62 pp.

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.

Prevec, R, Labandeira, C.C., Neveling, J., Gastaldo, R.A., Looy, C., Bamford, M., 2009. Portrait of a Gondwanan ecosystem: A new Late Permian locality from KwaZulu-Natal, South Africa. Review of Palaeobotany and Palynology 156, 454-493.

Appendix A – list of fossil plants collected by the Andersons from the Estcourt Formation in KwaZulu Natal (Anderson and Anderson, 1985).

Plant group – Estcourt Fm	Genus and Species	
Mosses	<i>Buthelezia mooiensis</i>	
Sphenophytes (horsetails)	<i>Sphenophyllum speciosum</i>	
	<i>Raniganjia kilburnensis</i>	
	<i>Phyllothea australis</i>	
	<i>Phyllothea lawleyensis</i>	
	<i>Phyllothea wetensis</i>	
	<i>Schizoneura gondwanensis</i>	
Ferns	<i>Sphenopteris lobifolia</i>	
Glossopterids	<i>Plumsteadia natalensis</i>	
	<i>Plumsteadia gibbosa</i>	
	<i>Estcourtia vandijkii</i>	
	<i>Estcourtia bergvillensis</i>	
	<i>Rigbya arberioides</i>	
	<i>Lidgettonia africana</i>	
	<i>Lidgettonia mooiriverensis</i>	
	<i>Lidgettonia inhluzanensis</i>	
	<i>Lidgettonia lidgettonioides</i>	
	<i>Lidgettonia elegans</i>	
	<i>Glossopteris symmetrifolia</i>	
	<i>Glossopteris loskopensis</i>	
	Ottocariaceae	
	Lidgettoniaceae	
Incertae sedis	<i>Noeggerathiopsis spathulata</i>	
	<i>Pagiophyllum vandijkii</i>	
	<i>Taeniopteris estcourtiana</i>	

	<i>Benlightfootia mooiensis</i>
Burgersdorp Formation	
Lycophytes (club mosses)	<i>Gregicaulus dubius</i>
Sphenophytes (horsetails)	<i>Calamites aliwalensis</i>
Ferns	<i>Asterotheca sp. A</i>
	<i>Cladophlebis sp. A</i>
Incertae sedis	<i>Burgersia papillophylla</i>
	<i>Dilatata kitchingii</i>
Peltaspermales (seed ferns)	<i>Lepidopteris brownie</i>
	<i>Lepidopteris madagascariensis</i>
	<i>Dicroidium highesii</i>
Ginkgoales	<i>Ginkgoites dutoitii</i>
	<i>Sphenobaiera stormbergensis</i>
	<i>Sphenobaiera browniana</i>
Cycadales	<i>Pseudoctenis brownie</i>
	<i>Nilsonia reservolensis</i>
Coniferales	<i>Sewardistrobus laxus</i>

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2018

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
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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	5	2
Masters	6	3
PhD	9	3
Postdoctoral fellows	5	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 2016 for Digby Wells
-) Alexander Scoping 2016 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 2017 for Digby Wells

xi) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books: over 110 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 22; Google scholar h index = 24;

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)