Palaeontological Impact Assessment for the proposed culverts on Road L1511, Bergville, Okhahlamba Local Municipality, KwaZulu Natal Province

Desktop Study (Phase 1)

For

Gedezar Consulting

20 March 2021

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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 Gedezar Consulting, 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 construction of a culvert on road L1511, about 3 km southeast of Ngoba and south of Woodstock Dam, Bergville area, Okhahlamba Local District, southwestern KwaZulu Natal. In order 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 project.

The proposed site lies on the Quaternary sands and alluvium that have weathered from older rocks and been transported along the river by the flowing water. Only if there are such traps along the watercourse, such as wetlands, abandoned oxbow lakes or channels, is there any chance of any younger fossils being preserved. The culvert is over a stream and on an existing road, with paths and tracks alongside it, so the culvert site is already highly disturbed and no surface fossils would survive. 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 the culvert and foundations have commenced.

Table of Contents

1. Background

As part of a larger project to upgrade the roads and improve access in the Okhahlamba local district, near Bergville, Road **L1511** about 3km southeast of Ngoba, crosses a seasonal stream (Figures 1, 2), therefore a culvert needs to be constructed so that the road is passable even in wet weather. This is an important access cross that links the villages in the region (Figure 2).

This part of the project involves three proposed culverts in the area between Bergville (east) and the Woodstock Dam (west) in the Thukela District Municipality. These culverts are situated along district roads L 2013, L1511 and L 1526 (with two culverts).
The GPS coordinates for the proposed culverts are:

L1511: S 28° 51' 57.47" E 29° 16' 47.60" – this report
L 2013: S 28° 46' 32.57" E 29° 14' 54.47" – this report**.**
L 1526: Culvert 1: S 28° 49' 38.59" E 29° 13' 15.67"
Culvert 2: S 28° 49' 36.18" E 29° 13' 12.67"

A Palaeontological Impact Assessment was requested for the Culvert project by Gedezar Consulting. 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	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

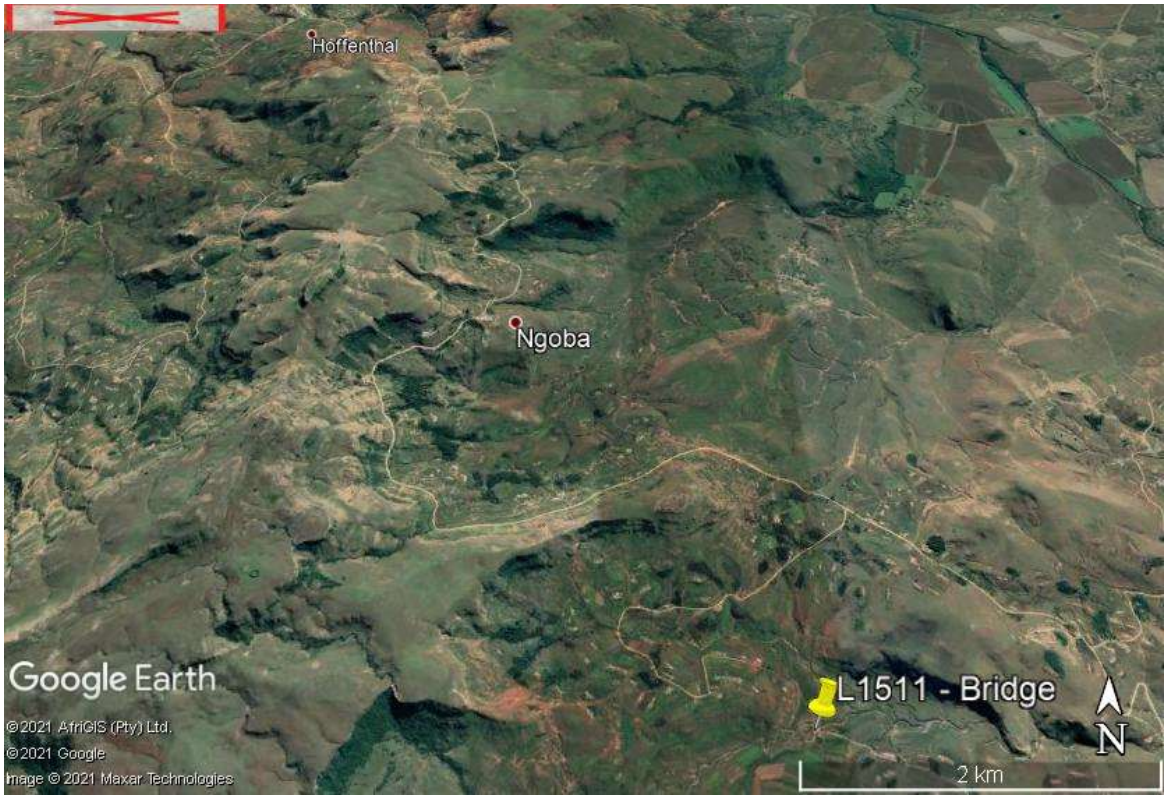

Figure 1: Google Earth Map showing the region around the proposed culvert or bridge for Road L1511, for orientation.

Figure 2: Google Earth map in more detail of the bridge site on L1511 shown by the pin. Note that the route is along existing tracks and paths. Map supplied by Gedezar Consulting.

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 lies in the southeastern part of the main Karoo Basin and the basal strata of the Karoo Supergroup are exposed in this region (Figure 3, Table 2).

The Karoo Basin is filled with the Karoo Supergroup rocks. The basin is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. 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 positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa. They melt deposits are known as the Dwyka Group and comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled.

Overlying the Ecca Group rocks are the Beaufort Group Rocks. The site lies in the south eastern sector of the Karoo Basin and the sediments are the alternating mudrocks and sandstones of the very thick, Adelaide Subgroup, Beaufort Group, Karoo Supergroup. They are late Permian in age with younger intrusive Jurassic-aged dolerite dykes occurring abundantly.

In this more eastern part of the Karoo Basin there are three formations in the Adelaide Subgroup, the basal Koonap Formation, then the Middleton Formation and the upper Balfour Formation (with five members, Rubidge, 2005; Smith at al., 2020). This part of the

Karoo Basin has not been studied as well as the western part and so the maps do not indicate which of the three formations is represented.

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.

Overlying the Beaufort Group strata are the fine to medium-grained sandstones and mudstones of the Stormberg Group that represent the drying out of the Karoo Basin during the Late Triassic and Early Jurassic, finally capped and preserved by the Drakensberg basalts. The basal Molteno Group (not exposed here) preserved abundant plant remains, and the middle Elliott Formation and upper Clarens Formations have a variety mammal-like reptiles and early dinosaurs. This group is not in the project footprint so will not be discussed further.

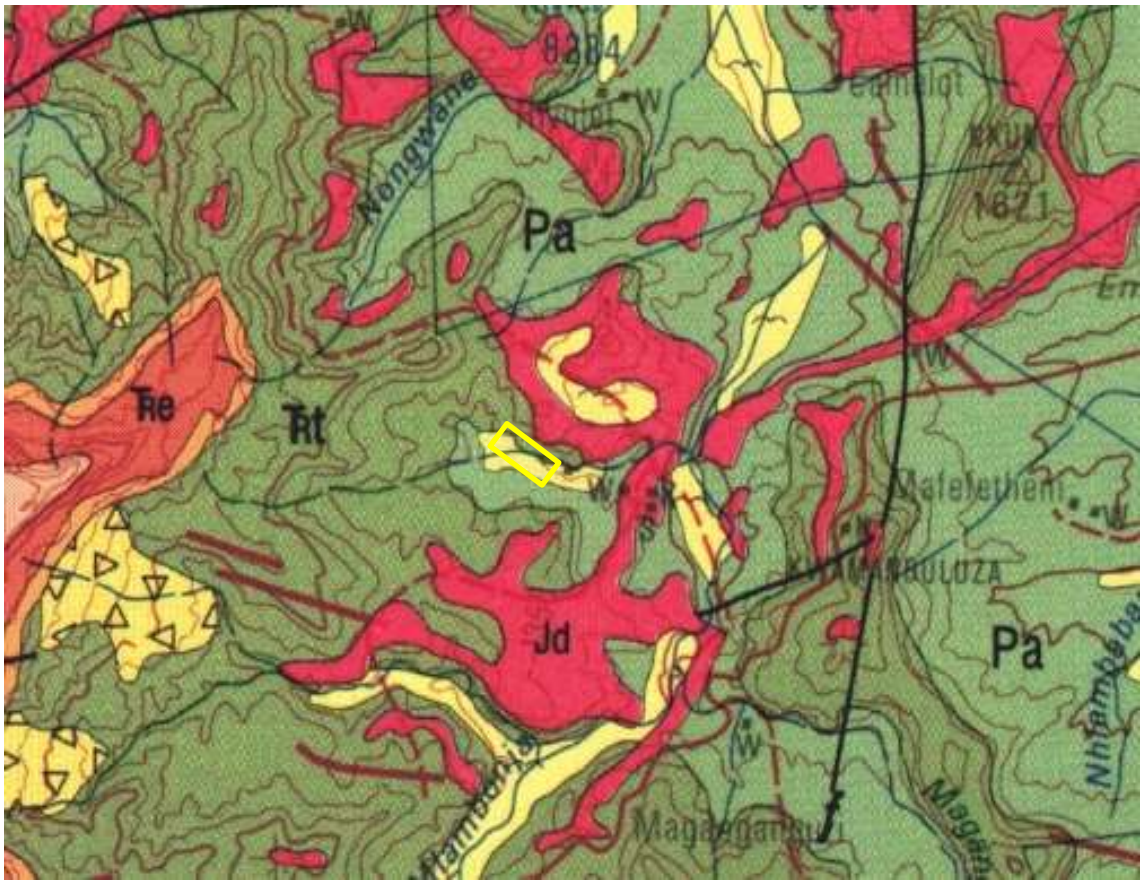

Figure 3: Geological map of the area around the proposed L1511 bridge over the Mayi River. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2828 Harrismith.

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

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Trc	Clarens Fm, Stormberg Group, Karoo SG	Yellow to pale red fine-grained sandstone	Early Jurassic
Tre	Elliott Fm, Stormberg Group, Karoo SG	Red to purple mudstones, fine-medium sandstones	Late Triassic to Early Jurassic
Pa	Adelaide Subgroup, Beaufort Group, Karoo SG	Grey-green shales, yellow-grey fine-grained sandstone	Late Permian, Early Beaufort
Pvo	Volksrust Fm, Ecca Group, Karoo SG	Dark grey shale	Middle Permian, Upper Ecca

Intruding through the Ecca and Beaufort Group strata are dolerite dykes that formed during the initial breakup of Gondwanaland and the massive eruption of basalts that form the Drakensberg Mountains. Forming the final capping and termination of the Karoo Supergroup is this Drakensberg Formation.

Along the rivers, however, are much younger deposits of Quaternary age alluvium, sand and scree that are composed of eroded and transported material from the older rocks.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is on the Adelaide Subgroup and close to Jurassic dolerite. Since dolerite is of volcanic origin it does not preserve any fossils, and so has low sensitivity (blue in the SAHRIS palaeosensitivity map).

Although the sediments making up the Quaternary alluvium are most likely derived from the Karoo Supergroup rocks, they are composed of weathered sands and soils. It is possible that in wetlands, abandoned oxbows and channels “newer” fossils could have been trapped and preserved, such as mammal bones, charcoal and plant fragments. Along a flowing river, however, where the bridge or culvert will be constructed, no such fossil traps are present.

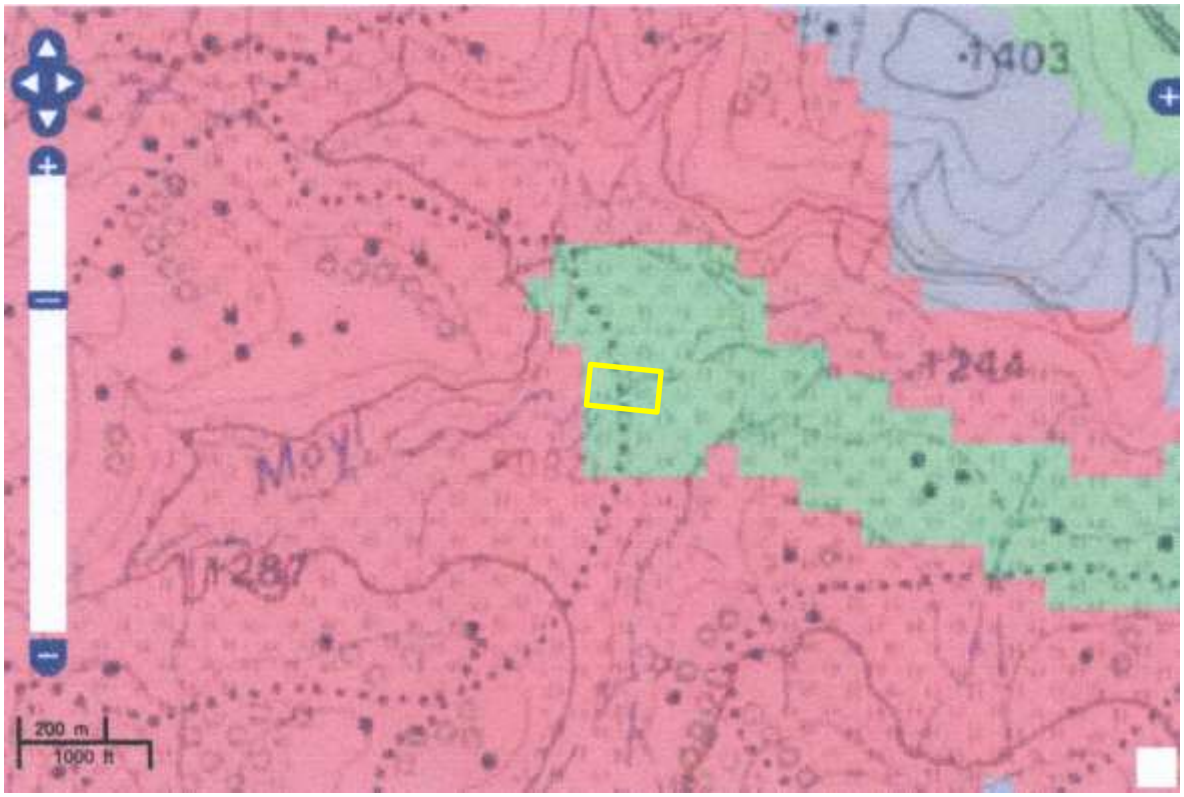

Figure 3: SAHRIS palaeosensitivity map for the site for the proposed bridge/culverts on L1511 over the Moyi River shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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 dykes do not preserve any fossils; so far there are no records from the Quaternary sands and alluvium of plant or vertebrate fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	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 or bones in wetlands, abandoned oxbows or channels of Quaternary age, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is unlikely that any fossils would be found in the loose surface soils and sand that is exposed by the existing paths and tracks. There may be fossils elsewhere in Quaternary traps, therefore a Fossil Chance Find Protocol should be added to the eventual EMPr.

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 either the wrong type to preserve fossils (dolerite) or represent transported and weathered alluvium and sands. Flowing rivers would not trap and preserve fossils. The surface is already very disturbed by the present paths and tracks. Since there is a very small chance that fossils from the Quaternary period may nearby and 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 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 sandstones, shales and sands are typical for the country and could contain fossil plants, insects, or invertebrate material. The chances however are extremely low of finding fossils in a flowing river channel because these are very

disturbed sites, and even if fossils were originally present, the water flow would have removed them. Furthermore, the route is already highly disturbed by foot traffic, and this is confirmed in the heritage report of Frans Prins (March 2021, his figures 11 and 12).

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is unlikely that any fossils would be preserved in the Quaternary alluvium and sands that have been transported by the river. The approach to the river crossing is also highly disturbed by foot traffic. There is a very small chance that fossils may occur in wetlands and abandoned oxbow or channels, if they occur in the vicinity, 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.

DeWit, M., Linol, B., (Eds), 2016. Origin and Evolution of the Cape Mountains and Karoo Basin. Springer International Publishing. pp. 141-149.

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.

Prins, F., March 2021. Phase one Heritage Impact Assessment for the proposed construction of three culverts near Bergville, Okhahlamba Local Municipality, KwaZulu Natal. Report by Active Heritage cc for Gedezar Consulting. 35pp.

Rubidge, B.S. (Ed), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). Biostratigraphy Series 1, South African Commission for Stratigraphy. Council for Geoscience, 46 pp.

Rubidge, B.S., 2005. 27th Du Toit Memorial Lecture: re-uniting lost continents — fossil reptiles from the ancient Karoo and their wanderlust. South African Journal of Geology 108: 135-172.

Smith, R.M.H., Rubidge, B.S., Day, M.O., Botha, J., 2020. Introduction to the tetrapod biozonation of the Karoo Supergroup. South African Journal of Geology 123(2), 131-140.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling for the culvert begins.

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, coal) should be put aside in a suitably protected place. This way the project 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 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/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 Quaternary sands and alluvium.

Figure 5: Fragments of bones recovered from a Quaternary river channel.

Figure 6: Photographs of a selection of silicified wood from a Quaternary river channel

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)