

**Palaeontological Impact Assessment for the proposed
construction of a Bulk Water Supply for Umgeni
Water – the Vulundlela project, south of Midmar Dam
KwaZulu Natal Province**

Site Visit/ Phase 2 Study

For

KSEMS

11 September 2019

Prof Marion Bamford

Palaeobotanist

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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 Naudi Consulting, Westville, for KSEMS, 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 Bulk Water Supply from Howick southwards to link with the existing DN450 and DN750 pipelines. 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 Phase 2 (site visit) Palaeontological Impact Assessment (PIA) was completed for the proposed project area.

The proposed site lies on the siltstones and fine grained sandstones of the Adelaide Subgroup (Beaufort Group) and the dark blue to grey shales of the middle Permian Volksrust Formation (Ecca Group). The latter could potentially contain fossil plant impressions of the *Glossopteris* flora, and the former could preserve vertebrates such as therapsids or reptiles. From the site visit survey there are NO fossils visible at the Howick West Reservoir 4 site, none along the roadside route to the potential split, none along the western option near the village of Mpophomeni A and none at pump station 2A. The southernmost section, the link to other pipelines, is on dolerite (zero palaeosensitivity) so was not visited.

Since there is a small chance that fossils could be discovered once excavations commence along the eastern alternative route a Fossil Chance Find Protocol should be added to the EMP. Based on this information it is recommended that no palaeontological site visit is required unless the geologist or responsible person discovers fossils.

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1. Background

Umgeni Water proposes to construct a Bulk Water Supply (BWS) pipeline with reservoirs and pump stations from the existing Howick West Reservoir (R4) to join the existing pipelines DN450 and DN750 (Figure 1). The first section of the route is south-southwest-wards to a point (29° 32' 05,98" S, 30° 12' 02,85" E). From here the preferred route is due south with a Midway Reservoir and continuation to Pumpstation 2A, called the east route here and shown in blue on Figure 1. This is the preferred route. The alternate route goes south-westwards along the border of the town Mpophomeni A and then joins at Pump station 2A, called the west route here and shown in pink in Figure 1. The last section is from Pump Station 2A to Reservoir 2.

Most of the route is in palaeontologically highly sensitive rocks so a Phase 2 (site visit) Palaeontological Impact Assessment was carried out on 7-8 September by Dr House in order 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). The report with observations was completed for the proposed development and is presented here.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (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
a ii	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	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	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 proposed route from Howick West southwards for the Umgeni Water Vulindlela BWS, south of Midmar Dam. The blue route is the preferred one (called the east route here), but the pink route is the alternative one (called the west route here). Map supplied by Ksems

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. (as reported herein);
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 central-eastern part of the Main Karoo Basin and comprises rocks of the lower Karoo Supergroup, in particular the Volksrust Formation (Ecca Group) and the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). There are large intrusions of dolerite dykes that were emplaced during the Jurassic and are associated with the massive basalt outpouring of the Drakensberg Mountains. The dykes do not preserve fossils because they are igneous in origin and, furthermore, tend to destroy fossils in their immediate vicinity. They will not be considered further.

The early Permian Volksrust Formation dark blue grey shales were deposited in deep water environments as the Karoo inland sea filled with meltwater from the receding glaciers from the mountainous region to the south. These are overlain by the siltstones and fine-grained sandstones of the Adelaide Group that were deposited by braided streams, floodplain and overbank deposits as the environment dried out slowly.

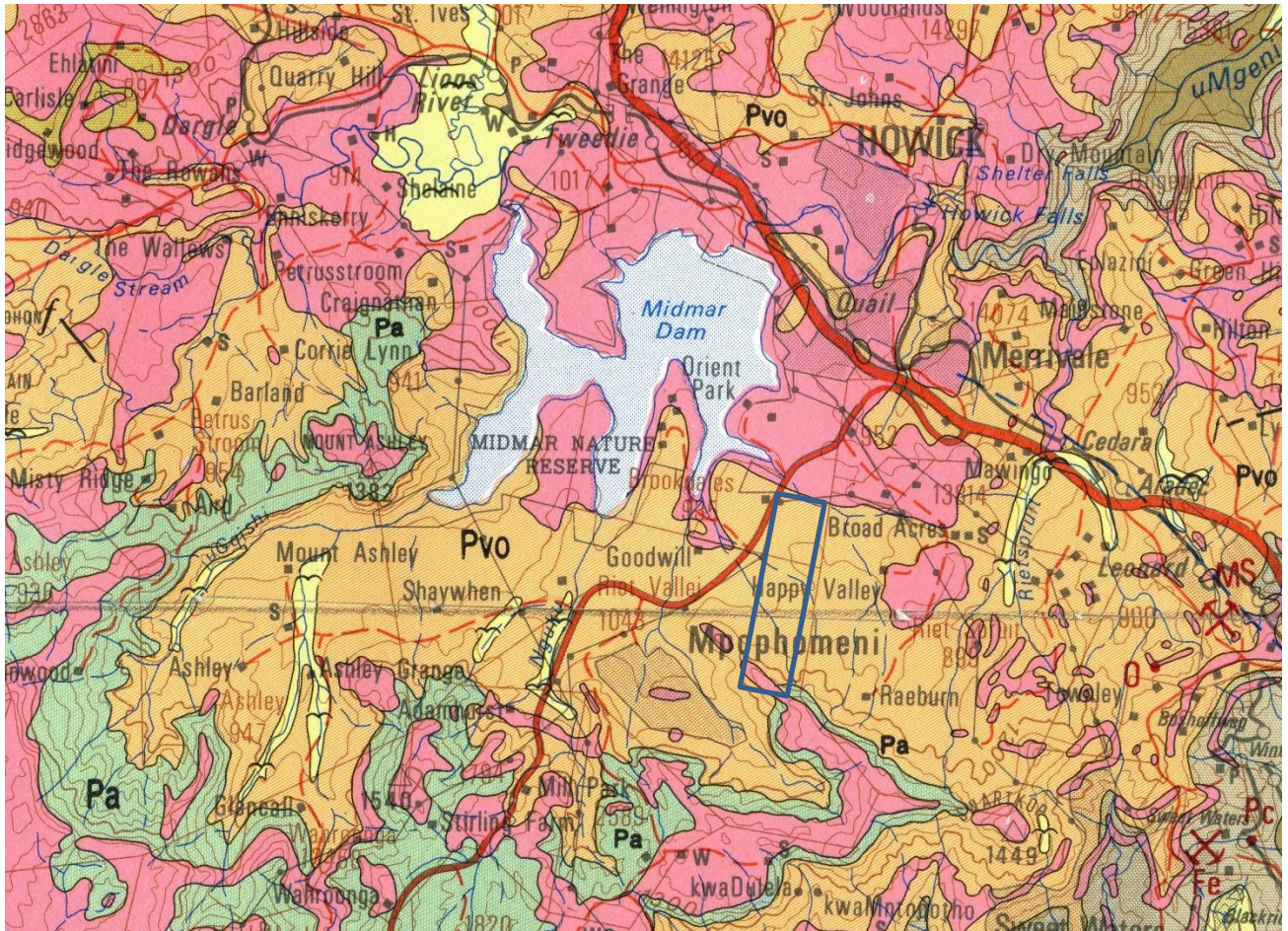


Figure 2: Geological map of the area around Howick and south of Midmar Dam with the proposed project indicated within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2930 Durban.

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
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa	Adelaide Subgroup, Beaufort Group, Karoo SG	Siltstone, fine-grained sandstone and subordinate mudstone	Late Permian
Pvo	Volksrust Fm, Ecca Group, Karoo SG.	Dark blue-grey shale	Early Permian

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is predominantly in the dark blue-grey shales of the Volksrust Formation

(Ecca Group, Karoo Supergroup) that are mid to late Permian in age. The Volksrust Formation potentially can preserve fossils of the *Glossopteris* flora, such as leaves, reproductive structures, root impressions, and other plant groups such as lycopods, sphenophytes and ferns (Plumstead, 1969; Anderson and Anderson, 1985). Only a small number of fish, reptiles and therapsids (mammal-like reptiles) had evolved by this time but bones are hardly ever preserved together with plant fossils because they require different depositional conditions. Very few fossil plants have been recorded from the Volksrust Formation, however, because they are deep water deposits. The older formation has coal deposits but these are absent from the Volksrust Formation.

There is a small outcrop of Adelaide Group rocks to the south of the pipeline route but this will not be impacted upon by the project. The southernmost section of the route, the link to existing pipelines DN450, is on dolerite (Figure 2, 3) which would not preserve fossils as it is igneous in origin, therefore this site was not surveyed.

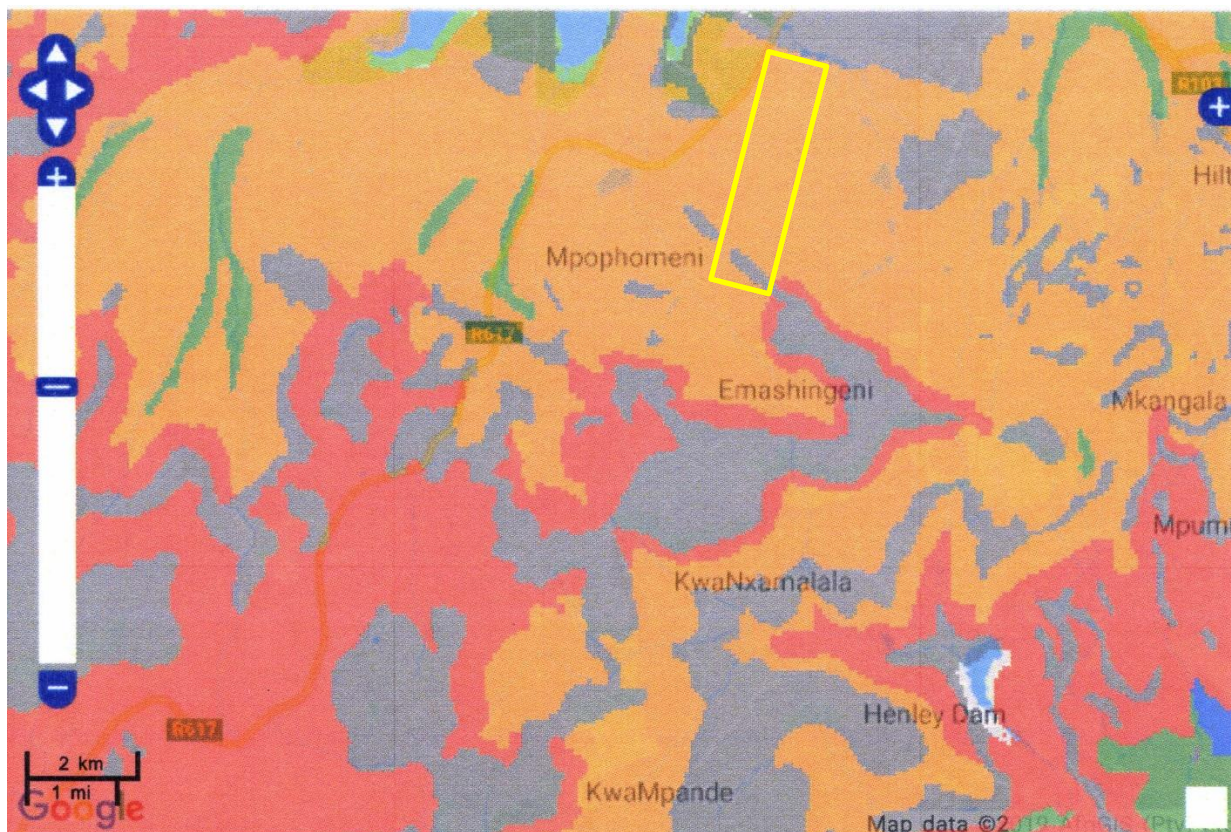


Figure 3: SAHRIS palaeosensitivity map for the proposed Vulindlela BWS, south of Midmar Dam, shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as highly sensitive (orange) and so a site visit was requested.

iii. Observations from site visit

The site was visited on 7 September and surveyed on foot where feasible. Adjacent to the roads only a cursory survey was done because the roads and margins are already disturbed by road building, telephone poles, other pipes and housing. Rocky outcrops were investigated for fossils using a geological hammer to reveal fresh surfaces.

Table 3: Locations, observations and related figures.

GPS coordinates	Observations	Figure
Stop 1 29° 31' 03" S 30° 13' 16" E	HW-R4 New pump station (Excavations and construction have already begun here but for a separate project and not impacting on this project). It was not safe to approach the active constructions but the lateral excavations showed the compacted shale horizons. Although this is the correct rock type to preserve fossils, none was observed.	4
Stop 2 29° 32' 52" S 30° 12' 05" E	Surveys along the road to Mpophomeni A (west (pink) alternative route) revealed no fossils, and no fossils were found in the rocks exposed in the quarry.	5
Midway Reservoir 29° 34' 02,36" S 30° 12' 15,1" E	The east (blue) route (directly north from the split, via Midway reservoir to Pump Station 2A) was across rough terrain with grasslands and thick vegetation. No fossils were seen.	No photos
Stop 3 29° 33' 28" S 30° 10' 48" E	Alongside Mpophomeni A residential area (west route). Area very disturbed by urban development and amenities. No fossils found	6
Stop 4 29° 34' 14" S 30° 11' 41" E	Pump Station 2A	7
End of route 29° 35' 42,15" S 30° 11' 51,51" E	Link of the Vulindlela BWS to the existing DN450 and DN750. This last section was not visited because it lies on the non-fossiliferous dolerite.	No photos



Figure 4: Photographs of the R4 reservoir area at Howick West. A – general view of construction site. B – excavation revealing the shales below the surface soils. C – fracturing and weathering of the weathered Volksrust Formation shales. D – close-up of the shales showing extreme weathering and oxidation with manganese (black) and iron (red) deposits on the fracture planes.

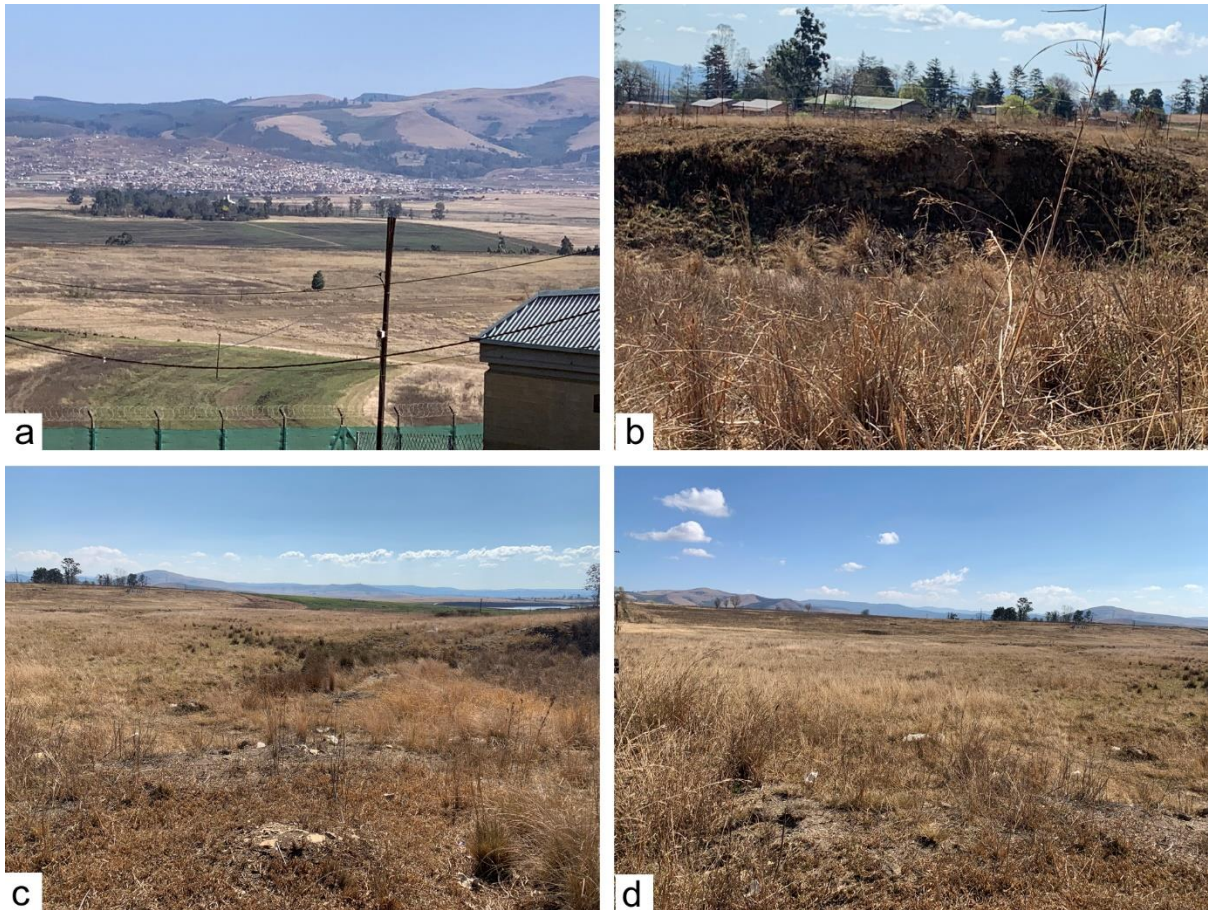


Figure 5: Photographs taken along the road from Howick West southwards to the split. The ground is disturbed and the underlying rocks have been revealed but there are no fossils.



Figure 6: photographs of the west alternative section alongside Mpophomeni A residential area.



Figure 7: Photographs of area around Pump station 2A. D – view of the route for the southern section of the eastern alternative and the Midway Reservoir would be placed on the hilltop.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 4:

TABLE 4A: 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 4B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	-
	L	Volksrust Fm plant fossils might occur in this region but the surface is highly disturbed. 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 <i>Glossopteris</i> flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	-
	L	No fossils were found in the soils of the Volksrust Fm of the main route and western option. They are unlikely to be found in the eastern route but this was not fully surveyed because of lack of access. Therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the site survey of the project route, there are no fossils in the surface soils or in the rocks that have been exposed by excavations, quarries and road infrastructure. According to the geological maps and the SAHRIS map, the eastern (preferred) route has the same geology and so the same fossil potential as the western route. Access to the Midway Reservoir site by fences, lack of roads and steep topography so this could not be verified. Since there is an extremely small chance that fossils from the Volksrust Formation well below the surface may be disturbed a Fossil Chance Find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate

material. The dolerite does not preserve fossils. The sediments in the site are already very disturbed, and the site visit showed that there were no fossils. It can be assumed, based on the site survey of the main and western routes, the eastern route, which has the same geology, also has the same lack of fossils.

6. Recommendation

Based on the site visit and experience and the lack of any previously recorded fossils from the area, it has been shown that there are no fossils preserved in the dolerite, soils of the village or ploughed field or around existing reservoirs and pipelines. The geology, and therefore the palaeontology of the eastern route, is expected to be the same but access was impeded and this could not be verified. Therefore, to err on the side of caution, a Fossil Chance Find Protocol should be added to the EMP: 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: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Claassen, M., 2008. A note on the biostratigraphic application of Permian plant fossils of the Normandien Formation (Beaufort Group, northeastern Main Karoo Basin), South Africa. South African Journal of Geology 111, 263-280.

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.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations for foundations 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, coal) should be put aside in a suitably protected place. This way the mining 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 Figures 4, 5). 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 the site inspections by the palaeontologist will not be necessary.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossil plants from the Vryheid Formation

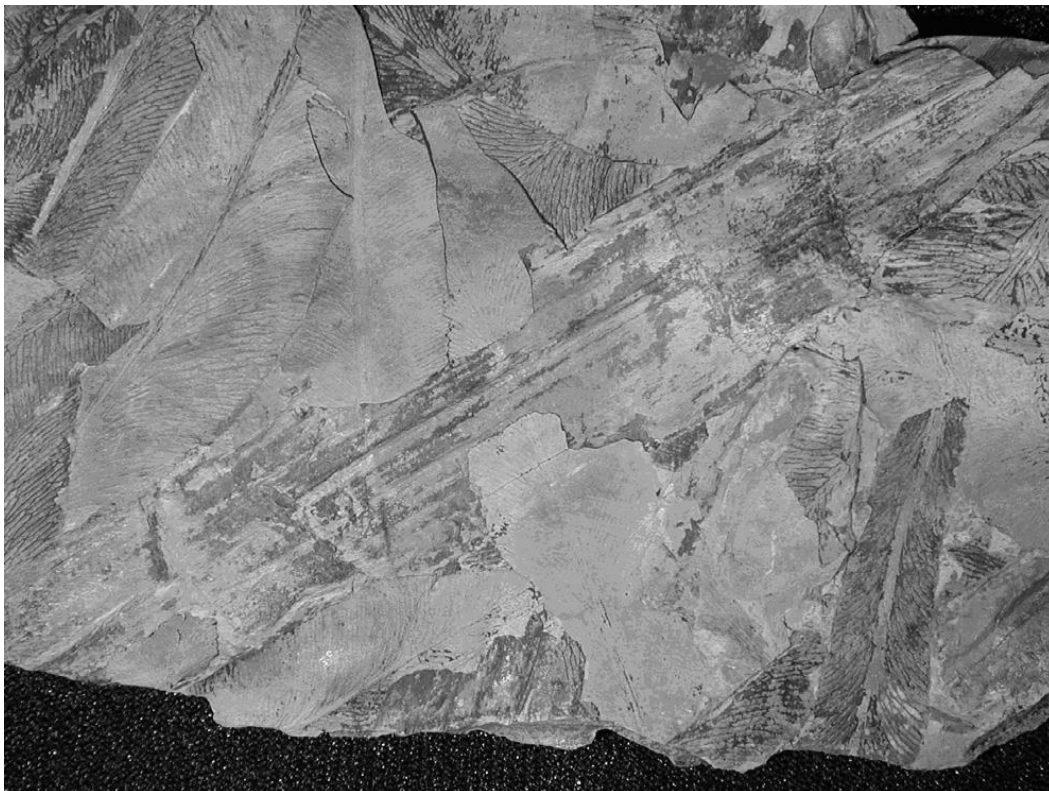


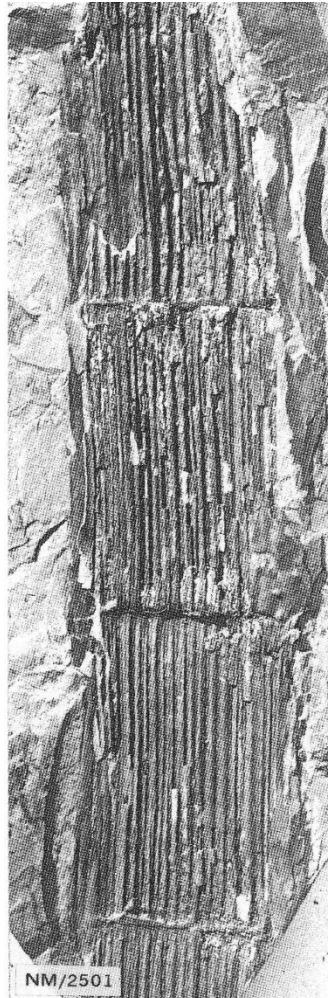
Figure 8: examples of *Glossopteris* flora plants from the Normandien Formation (from Claassen, 2008, fig 4a).



Figure 9: Example of fossil plants from the Normandien Fm, the reproductive structure *Rigbya arberioides* (From Claassen, 2008, fig 6g)



Fern: *Asterotheca* sp.



Sphenophytes: whorls of leaves on a striated stem

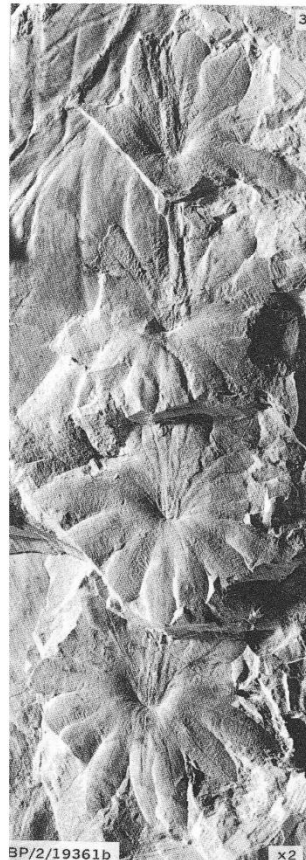


Figure 10: more plant impressions from the Vryheid Formation.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD June 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
- 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

xi) Research Output

Publications by M K Bamford up to June 2019 peer-reviewed journals or scholarly books: over 130 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)

Short CV for *Alisoun Valentine House*

084 5870023

alisoun.house@wits.ac.za

WORK HISTORY

Postdoc Fellow – Evolutionary Studies Institute

January 2017 – December 2019

Analysis of archaeological charcoal from Middle Stone Age and Early Iron Age sites

Host: Professor Marion Bamford

Sessional position – School of Animal, Plant and Environmental Sciences

March 2016 – November 2016

Academic support for postgraduate students

Short term internship – University of the Witwatersrand

August – November 2015

Assistant to Editor for 'Flora of the Witwatersrand' – University of the Witwatersrand

September 2008 – February 2010

Assisted with editing and preparing the Flora for publication

Tutor at the College of Science – University of the Witwatersrand

Academic years 2000 – 2003

EDUCATION

Doctor of Philosophy (PhD) University of the Witwatersrand (2015)

Title: Systematic Applications of Pollen Grain Morphology and Development in the Acanthaceae

Supervisor: Professor Kevin Balkwill

Master of Science (MSc) University of the Witwatersrand (1991)

Title: A developmental study of *Nephroselmis viridis* (Inouye, Suda et Pienaar)

Prasinophyceae

Supervisor: Professor Richard Pienaar

Degree awarded with Distinction.

Bachelor of Science with Honours (B.Sc. Hon.) University of the Witwatersrand (1987)

Awarded the Florence D. Hancock prize for a Dissertation in Phycology (1988)

Higher Diploma in Education (Postgraduate) for Secondary Education University of the Witwatersrand (1985)

Teaching subjects: Biology and Science

Bachelor of Science (B.Sc.) University of Witwatersrand (1984)

Major: Botany; Sub-majors: Microbiology and Zoology

Matriculation Certificate Hyde Park High School (1979)

Subjects passed: English, Afrikaans, Biology, Mathematics, Geography, Home Economics

PUBLICATIONS

Young A.V. and Pienaar R.N. 1989. The ultra structure of a new species of *Nephroselmis* (Prasinophyceae). Proceedings of the Electron Microscopy Society of Southern Africa. 19: 113–114.

House A. and Balkwill K. 2013. FIB-SEM: An Additional Technique for Investigating Internal Structure of Pollen Walls. Microscopy & Microanalysis 19: 1535–1541.

House A. and Balkwill K. 2014. FIB-SEM: A new technique for investigating pollen walls. Microscopy: advances in scientific research and education (A. Méndez-Vilas, Ed.) 1: 54–58.
© FORMATEX.

House A. and Balkwill K. 2016. Labyrinths, columns and cavities: new internal features of pollen grain walls in the Acanthaceae detected by FIB-SEM. Journal of Plant Research 129: 225–240.

House A. and Balkwill K. 2017. FIB-SEM enhances the potential taxonomic significance of internal pollen wall structure at the generic level. Flora-Morphology, Distribution, Functional Ecology of Plants 236–237C: 44–57.

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PALAEONTOLOGICAL IMPACT FIELD EXPERIENCE

May 2018 – SARAO Williston and Carnarvon for Digby Wells
August 2019 – Idlanga Coal MR, Rietvlei, Vryheid area – Digby Wells
September 2019 – Schmidtsdrift PR for Thaya Environmental Specialist
September 2019 – Estcourt Pvt Hospital for EnviroPro