Palaeontological Impact Assessment for the proposed Nquthu Pipeline, east of Dundee, KwaZulu Natal Province

Desktop Study (Phase 1)

For

ASHA Consulting (Pty) Ltd

14 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 ASHA Consulting (Pty) Ltd, Lakeside, 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 pipeline between the town of Nquthu and Hlati-Dlamini, about 30km east of Dundee, KwaZulu Natal Province.

To comply with 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) incorporating site observations by the archaeologist was completed for the proposed development.

The proposed route lies on potentially fossilferous rocks of the Vryheid Formation and the Volksrust Formation (Ecca Group, Karoo Supergroup) as well as non-fossiliferous dolerite of Jurassic age. Impressions of plants of the *Glossopteris* flora can occur in these strata but the distribution is sporadic and difficult to predict. The entire route is along the disturbed road and pipe servitude of the R64 so even if fossils were preserved in the rocks, the overlying soils and alluvium have been excavated or removed and replaced with other material. No fossils were seen by the archaeologist and they would likely not be visible unless they were revealed in new excavations. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no specialist palaeontological site visit is required unless fossils are discovered once excavations have commenced.

Table of Contents

1. Background

The proposal to upgrade and extend the current water pipeline from Vant's Drift (west), via Hlati-Dlamini to Nquthu in the east (Figures 1-3) is required in order to meet the current and medium term water needs of the area. The project will comprise of three main aspects as follows:

1. The existing Vant's Drift Pump Station will be upgraded to allow for a greater capacity. This will involve the installation of three new pumps;
2. Corrosion protection measures will be applied to the existing steel rising main in order to prolong its lifetime (it is possible that certain sections may require replacement within the same trench if their condition is beyond salvation); and
3. A new 15.1 km long and 600 mm diameter ductile iron rising main pipeline will be constructed from Vant's Drift to the terminal water reservoir in Nquthu town. The pipeline will be outside of the R68 road reserve. It will need to be buried with a minimum 800 mm cover in non-trafficked areas, but all areas alongside or beneath roads will be buried with at least 1000 mm soil cover.

Several streams and rivers will be crossed. The preferred method is to trench into the stream beds and bury the pipeline below the streams. Where roads need to be crossed, a trench will be excavated across these roads. Almost all roads are gravel.

SITE DESCRIPTION
The town of Nqutu is about 30 km south of Dundee in KwaZulu Natal, at 28° 12' 58.74" S and 30° 39' 34.35" E and is close to the Buffels River. The R64 runs more or less due west southwest from Nquthu to Hlati-Dlamini (at 28° 14' 03.23" S and 30° 31' 04.94" E).

A Palaeontological Impact Assessment was requested for point 3 of the project. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is 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

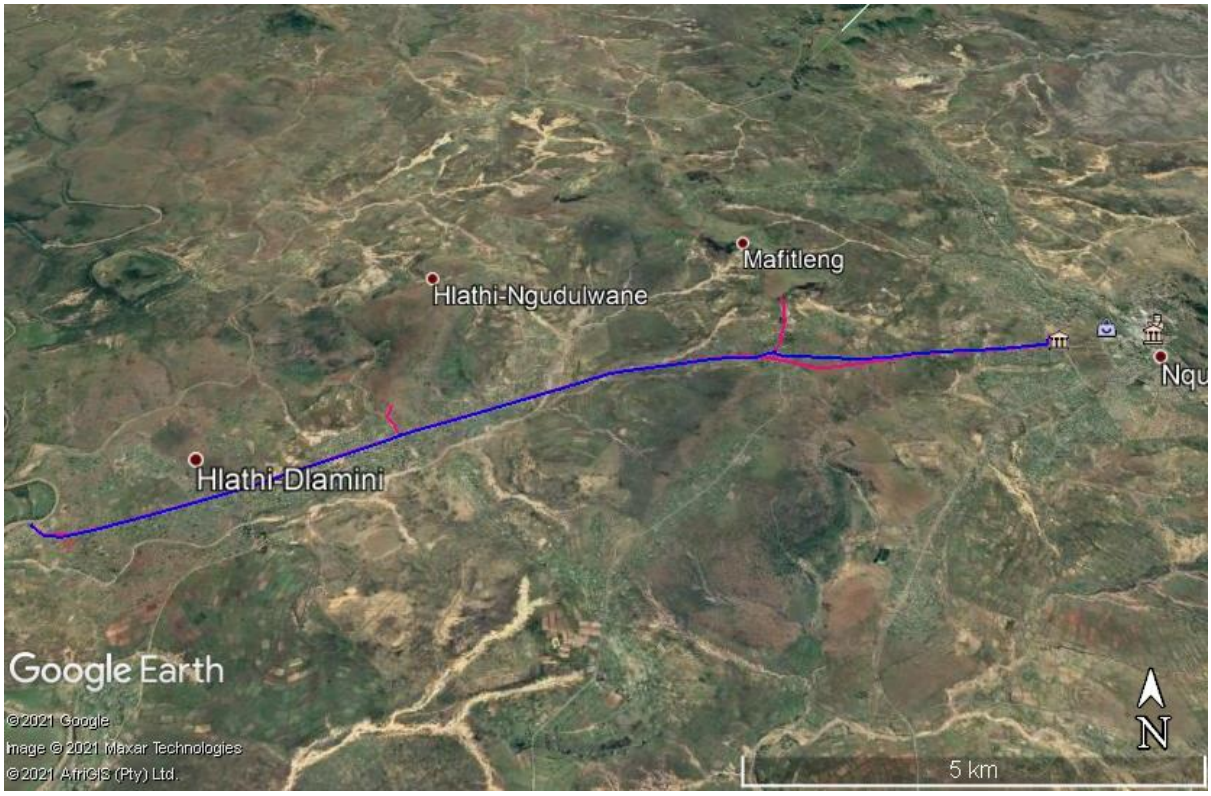

Figure 1: Google Earth map of the proposed water pipeline route between Vant's Drift (west), via Hlati-Dlamini and to Nquthu (east). Map supplied by ASHA.

Figure 2: Google Earth map at higher resolution of the western sector and Vant's Drift the proposed pipeline.

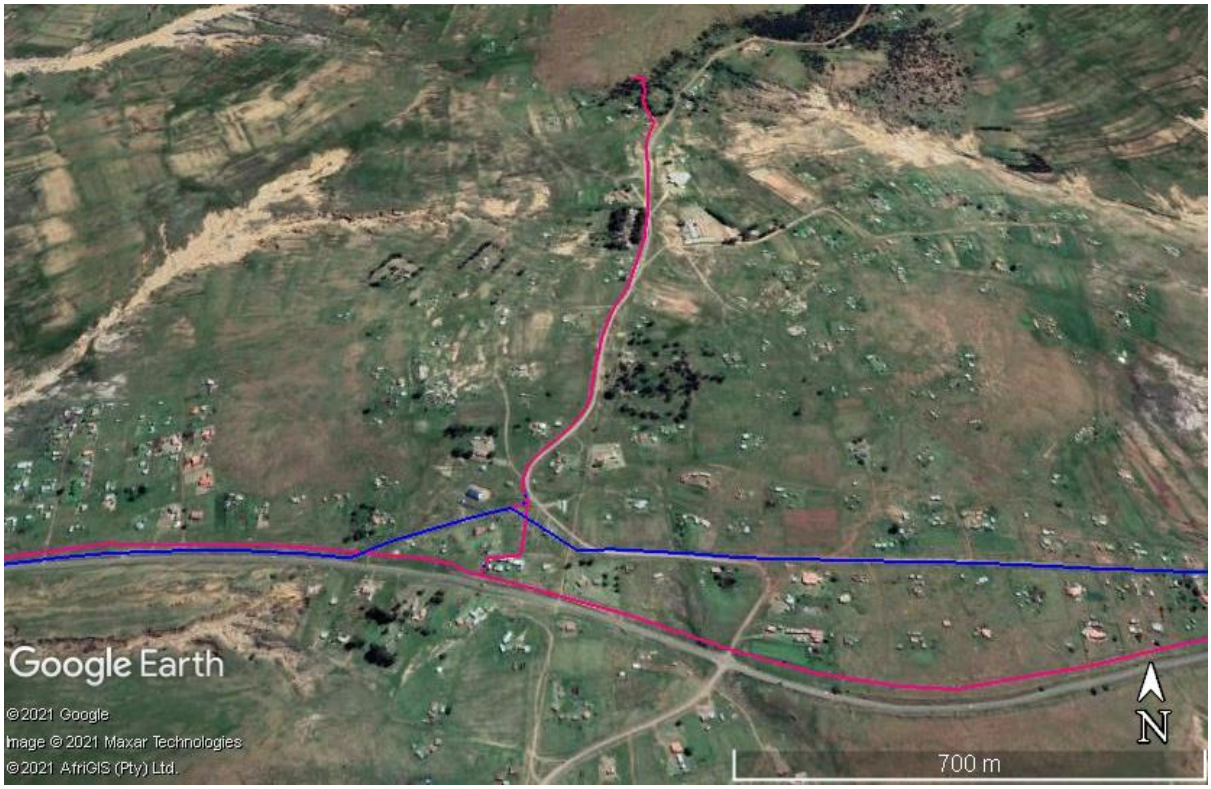

Figure 3: Google Earth map at higher resolution of the Mafiteng sector of the proposed pipeline.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

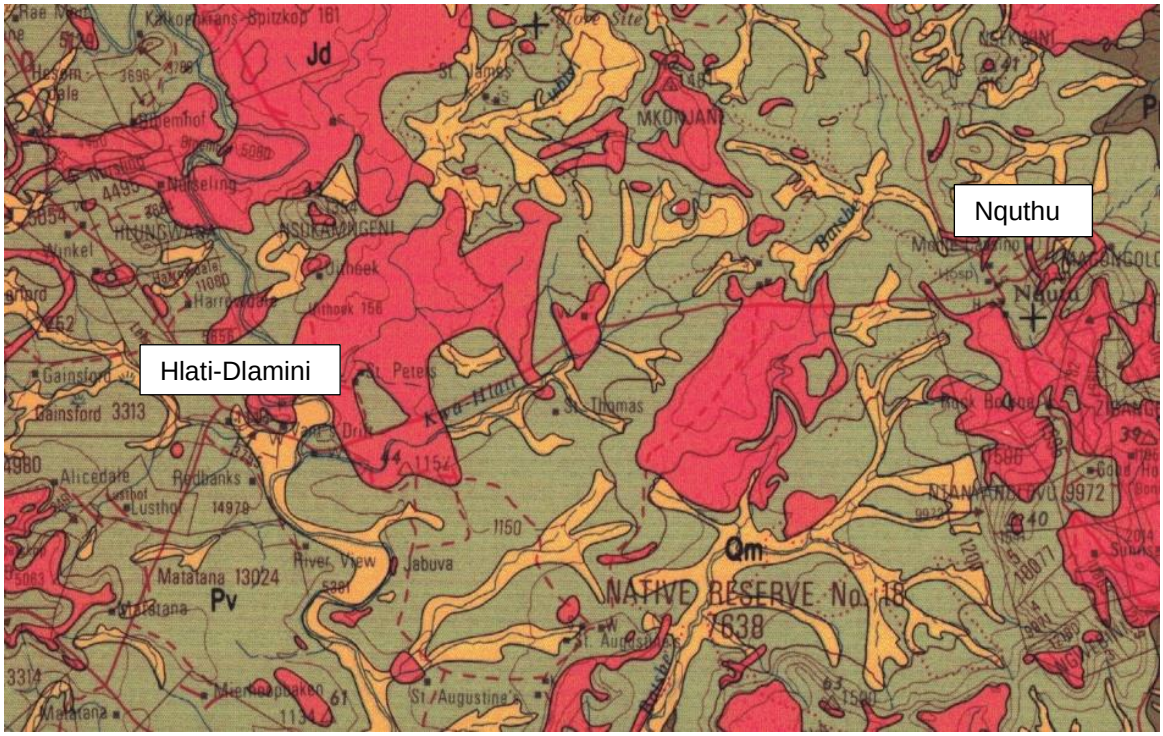

Figure 4: Geological map of the area around the proposed Vant's Drift – Hlati-Dlamini – Nquthu water pipeline. Towns as indicated. Pipeline route is along the road (red line). Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2830 Dundee.

Table 2: Explanation of symbols for the geological map and approximate ages (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
Pvo	Volksrust Fm, Ecca Group, Karoo SG	Shales, sandstones, mudstones	Late Permian, Upper Ecca
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest (Nieuwoudville – Inverdoorn) and across to almost the KwaZulu Natal south coast. It 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 was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin; they are known as the Dwyka Group (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the Free State and KwaZulu Natal, from the base upwards are the Pietermaritzburg Formation, Vryheid Formation and the Volksrust Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

Overlying the Ecca Group rocks are the Beaufort Group Rocks that are late Permian and early Triassic in age, but they are not present in this part of the basin. Intruding through the Karoo strata are dolerite dykes from the Jurassic period which are associated with the massive basalt outpourings that capped the Karoo Basin sediments and preserved them.

ii. Palaeontological context

The Vryheid Formation in particular, and the slightly younger Volksrust Formation, do not have fossil animals but can preserve fossil plants of the Glossopteris flora. Although *Glossopteris* leaves, seeds and fructifications are dominant, other plants occur such as cordaitaleans, early gymnosperms, lycopods, sphenophytes and ferns, plus rare insects. Coal seams are common in the Vryheid Formation and collieries are common in the Klip River coalfield to the east of this project area (Snyman, 1998). No collieries occur in the study area because the seams are not economically viable for mining, or are absent. Coal itself does not preserve any fossils because the original peats have been buried over time, then altered by heat and pressure, so that no original plant material is discernible. Shale lenses between the coal seams can preserve recognisable fossil plants but their distribution is erratic and unpredictable (Plumstead, 1969).

The Vryheid Formation represents a fluviodeltaic system while the Volksrust Formation represents a deep to shallow lacustrine to marine environment (Catanuneau et al., 1998; Bamford, 2004). Fragmentary plant fossils have been mentioned from the Volksrust Formation (Johnson et al., 2006) and one example only of a marine bivalve, *Megadesmus* (Cairncross et al., 2005).

The palaeontological sensitivity of the area under consideration is presented in Figures 5 and 6. Showing the western route from Vant's Drift - Hlati-Dlamini and eastern route to Nquthu, respectively.

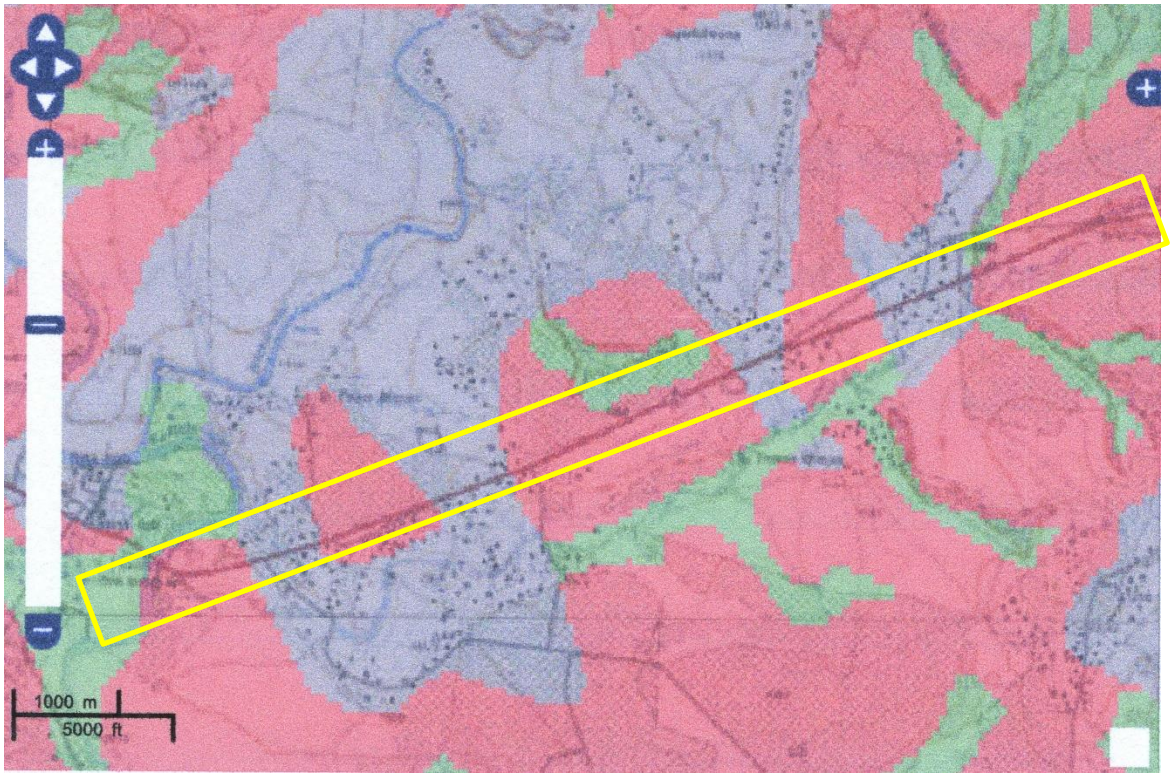

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed western part of the Vant's Drift - Hlati-Dlamini - Nquthu pipeline shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

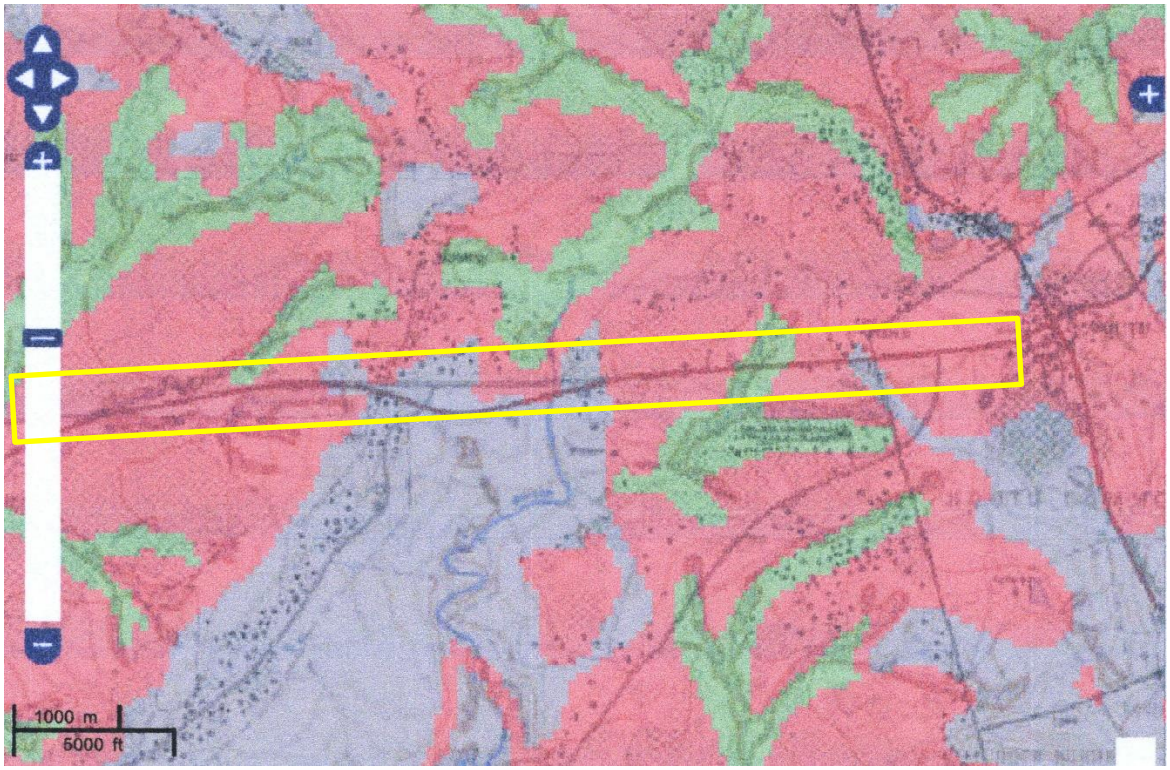

Figure 6: SAHRIS palaeosensitivity map for the site for the proposed eastern part of the Nquthu pipeline shown within the yellow rectangle. Background colours as above.

From the SAHRIS maps above, the route is indicated as passing through three levels: very highly sensitive (red), moderately sensitive (green) and of insignificant to zero (grey) sensitivity. In this region the red areas apply to the Vryheid Formation, the green to Volksrust Formation and grey for the dolerite dykes.

iii Site Visit – preliminary survey

Figure 7: Western section of the pipeline route. Note the vegetation cover and no rocky exposures; no fossils. (Photo taken by Jaco van der Walt (JvdW)).

Figure 8: Western section showing the pump house built on artificially raised ground (Photo by JvdW).

Figure 9: Central section of pipeline. Note the disturbed ground and large pebbles. No fossils. (Photos JvdW).

Figure 10: Central section of pipeline and exposed rocks and gravel in the riverbed. This material is all transported so out of context. No fossils. (Photo by JvdW).

Figure 11: Central section of pipeline. Note the residences and the cleared land for agriculture or grazing. Deep soil cover and no fossils visible. (Photo by JvdW).

Figure 12: Western section near the reservoir. Boulders are weathered dolerite so no fossils would be present. (Photo by JvdW).

Figure 13: Western section. Note the dolerite boulders, powerlines, roads and houses all having disturbed the soils and rocks. No Fossils. (Photo by JvdW).

Aerial photography suggested that minimal or no bedrock exposure was to be expected on site. For this reason, no specialist palaeontological site visit was carried out. The route was surveyed by the project field archaeologist during the first week of April (Figures 7-13) but no fossils were seen. This is unsurprising since the land is covered by soils and vegetation and has been disturbed by previous urban and rural activities. There were no outcrops of shales or mudstones that could potentially have fossil plant impressions.

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	Soils do not preserve plant fossils; so far there are no records from the Vryheid Fm of plant or animal fossils in this region so it is very unlikely that fossils occur on the disturbed route. 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 from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	It is very unlikely that any fossils would be found in the loose soils and sand that will be excavated BUT fossil may occur below ground in bedrock. Therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.
	L	-

Based on the nature of the project, subsurface 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 contain plant fossils, except for the dolerite. However, the proposed route is already highly disturbed from the current pipeline, adjacent road and servitude. The overlying soils, gravel and alluvium will not preserve fossils. The survey confirmed that there are no surface fossils. Since there is an extremely small chance that fossils from the below ground Vryheid Formation may be disturbed ONLY when excavations commence, 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 dolorites, sandstones, shales and sands are typical for the country and, except for the dolorites, may contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. Vertebrate fossils are not known from the Vryheid Formation. No surface fossils would have survived the previous road and pipeline construction or urban developments but it is not known what lies below the ground surface.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the disturbed surface soils and alluvium, as confirmed during the survey. There is a very small chance that fossils may occur in the below ground shales of the early Permian Vryheid Formation so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations for the pipeline have commenced, then they should be rescued, photographed and a palaeontologist called to assess and possibly collect a representative sample.

7. References

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

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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.

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.

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

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Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. Palaeogeography, Palaeoclimatology, Palaeoecology 70, 377-391

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 14). 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 well preserved and scientifically useful fossil material found by the developer/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 no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Vryheid Formation (Ecca Group), Karoo Supergroup).

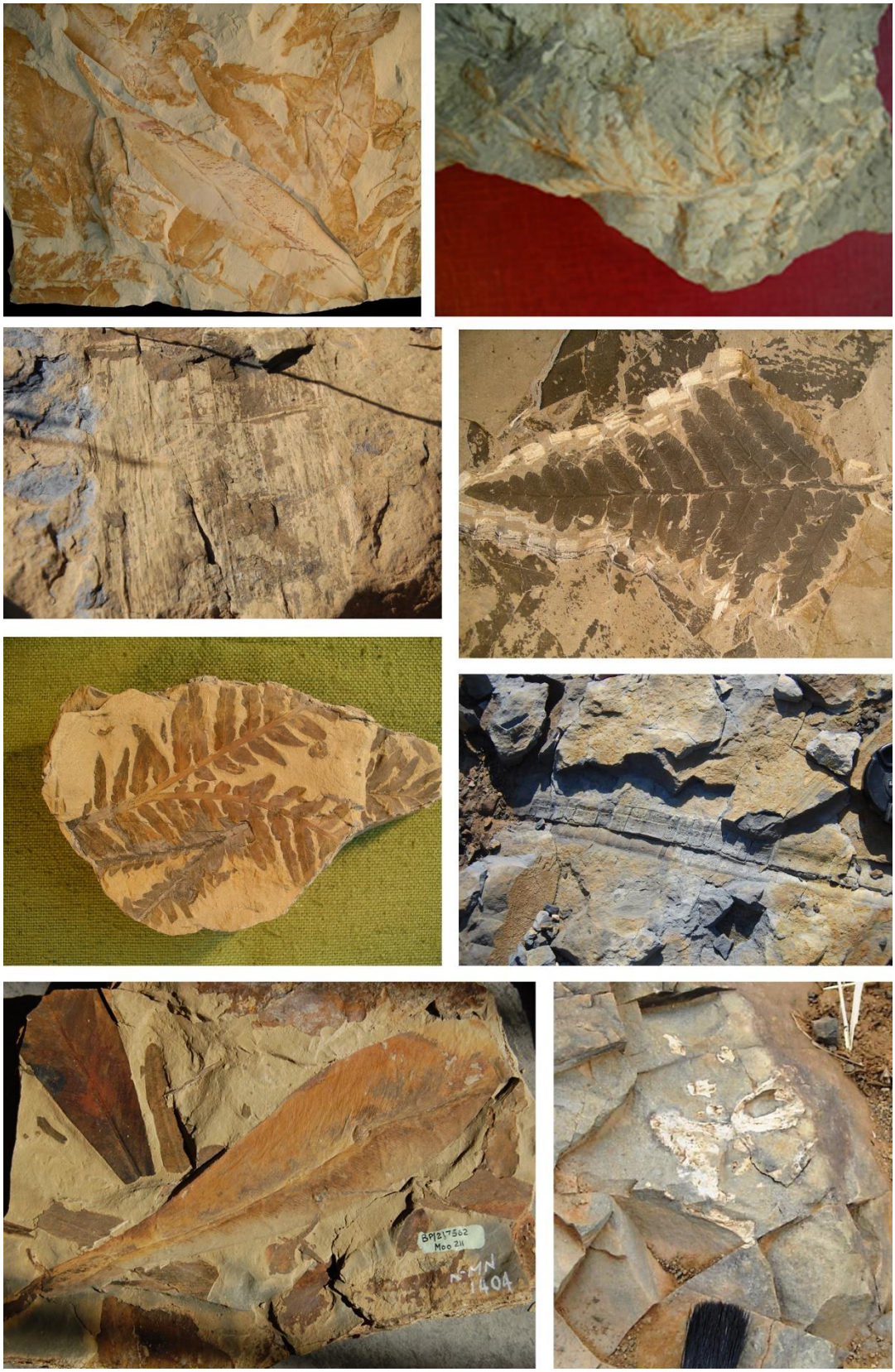

Figure 14: Examples of fossil plants from the *Glossopteris* flora, Vryheid Formation, with an example of in situ vertebrate bones in the bottom right.

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)