



## **NGT ESHS Solutions**

### **PROJECT TITLE:**

**BASIC ASSESSMENT REPORT FOR THE PROPOSED KWATHEMA TO  
GRUNDLINGH WWTW BULK OUTFALL SEWER: CAPITAL PROJECT  
IMPLEMENTATION NEAR NIGEL, GAUTENG PROVINCE**

### **DATE OF ISSUE:**

**31 OCTOBER 2018**

### **SPECIALIST REPORT:**

**Palaeontological Impact Assessment for the  
proposed KwaThema to Grundligh Wwtw Bulk  
Outfall Sewer**

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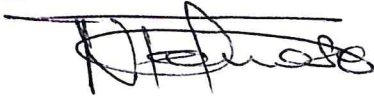

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**DECLARATION OF INDEPENDENCE**

Marion Bamford for NGT has compiled this report. 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.

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## **EXECUTIVE SUMMARY**

For the proposed project, the Kwathema to Grundligh Wwtw Bulk Outfall Sewer in the Nigel and Dunnottar area, Munny Consultants has subcontracted NGT to carry out a Palaeontological impact Assessment. 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 project to provide water to the community.

### **Conclusions:**

In the central part of the project area the Klipriviersberg Group mafic lavas and tuffs do not preserve fossils as they are too old for body fossils and are volcanic in origin. These rocks are indicated as blue in the map (low sensitivity). Around this central area are rocks of the Malmani Group that may preserve trace fossils, stromatolites. Around the periphery of the project area are sandstones and shales of the Vryheid Formation of the Ecca Group, early Permian, and these could potentially preserve fossil plants of the Glossopteris flora but only the distal ends of the pipeline fall in this rock formation.

### **Recommendations:**

Since there is a small chance of fossils being disturbed when excavations commence, a Fossil Chance Find Protocol should be added to the EMPr so that a representative collection can be made if they occur there.

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**LIST OF ABBREVIATIONS**

<b>ACRONYMS</b>	<b>DESCRIPTION</b>
<b>AUTHORITIES</b>	
ASAPA	Association of South African Professional Archaeologists
FSPHRA	Free State Provincial Heritage Resources Authority
NGT	Nurture, Grow, Treasure
SADC	Southern African Developing Community
SAHRA	South African Heritage Resources Agency
<b>DISCIPLINE</b>	
AIA	Archaeological Impact Assessment
BAR	Basic Assessment Report
CMP	Cultural Management Plan
ESA	Early Stone Age
EIAs	Environmental Impact Assessment
EMPr	Environmental Management Programme
EIA	Early Iron Age
HCMP	Heritage Cultural Management Plan Report
HIA	Heritage Impact Assessment
LIA	Late Iron Age
LSA	Late Stone Age
MIA	Middle Iron Age
MSA	Middle Stone Age
PIA	Palaeontological Impact Assessment
ToR	Terms of Reference
<b>LEGAL</b>	
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act



## **TERMS AND DEFINITIONS**

### ***Archaeological resources***

These include:

- Material remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;
- Rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- Wrecks, being any vessel or aircraft, or any part thereof which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
- Features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

### ***Palaeontological***

This means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial.

### ***Cultural significance***

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

### ***Development***

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in the change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

- Construction, alteration, demolition, removal or change in use of a place or a structure at a place;
- Carrying out any works on or over or under a place;

- Subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
- Constructing or putting up for display signs or boards; any change to the natural or existing condition or topography of land;
- And any removal or destruction of trees, or removal of vegetation or topsoil.

***Heritage resources:*** This means any place or object of cultural significance.

## 1. INTRODUCTION

As part of a larger project between Nigel and Dunnottar this report deals with the proposed KwaThema to Grundligh Wwtw Bulk Outfall Sewer pipeline for which Munny Consultants has subcontracted NGT to carry out a Palaeontological impact Assessment. 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 project to provide water to the community.

*Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)*

<b>A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:</b>	<b>Relevant section in report</b>
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 <b>Error! Bookmark not defined.</b>
An indication of the scope of, and the purpose for which, the report was prepared	Section <b>Error! Reference source not found.</b>
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 <b>Error! Reference source not found.</b> <b>Error! Reference source not found.</b>
An identification of any areas to be avoided, including buffers	N/A
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
Any mitigation measures for inclusion in the EMPr	N/A
Any conditions for inclusion in the environmental authorisation	N/A
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A



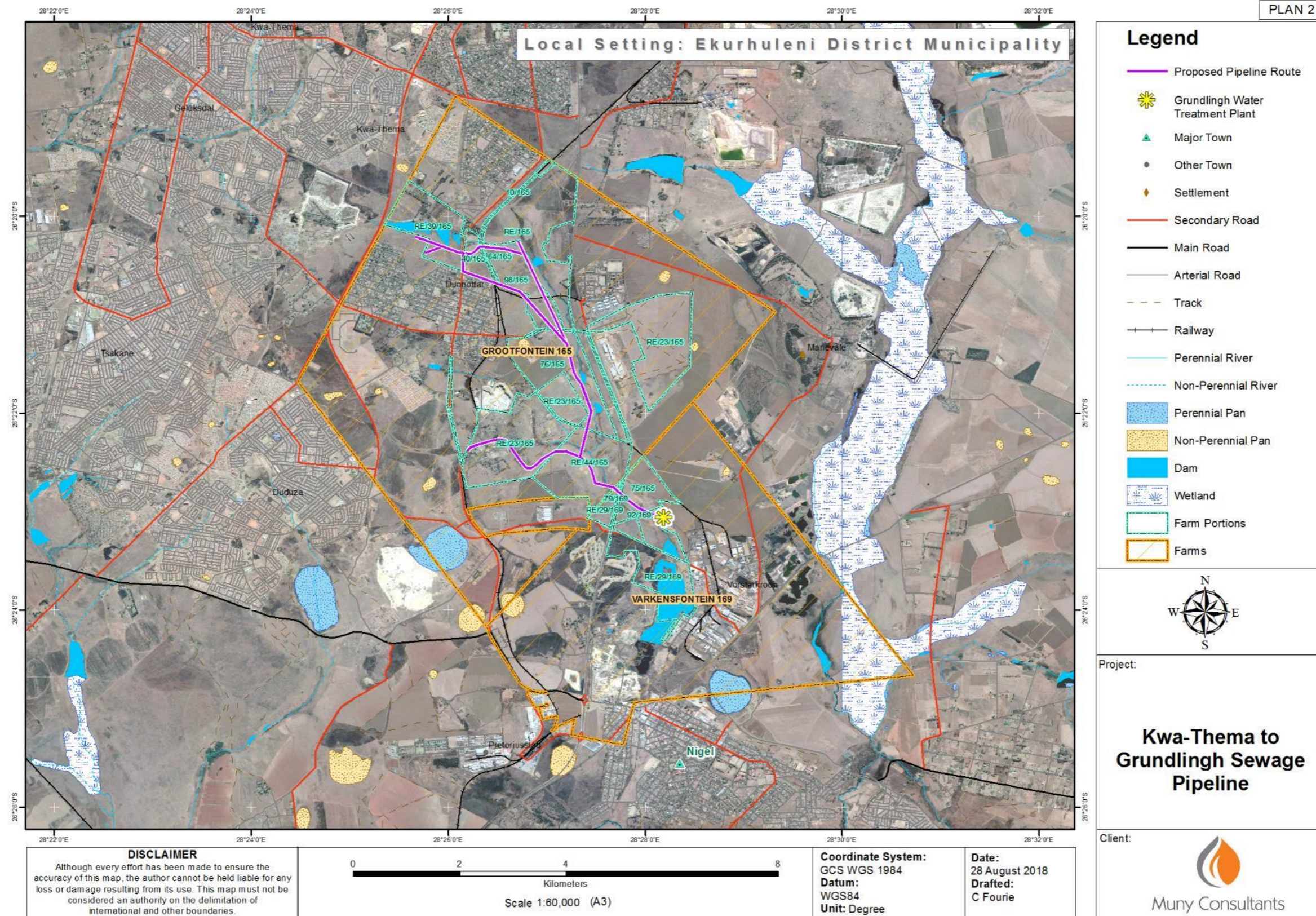


Figure 1: Google Earth map of the proposed development of the KwaThema to Grundlingh bulk sewer supply pipeline near Dunnottar and Nigel. (Map supplied by Muny Consultants.)



## 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 PALAEOLOGY

#### 3.1. Project location and geological context

The routes for the pipelines are on rocks of the Malmani Subgroup, Chuniespoort Group (Figure 2, Table 2) for the central portion, surrounded by the Klipriviersberg Group. Around these are rocks of the Vryheid Formation which are considerably younger. Only the distal parts of the pipeline will impact on the Vryheid Fm.

Quartzites and shales of the Government Subgroup, West Rand Group, Witwatersrand Supergroup are the oldest rocks in the area and are part of the gold-bearing complex in the Witwatersrand Basin. The other rocks of the Witwatersrand Basin are also ancient. The meteorite impact that formed the Vredefort dome more than 2 000 million years ago exposed the basement rock in the centre and up-tilted and exposed the old rocks of the Central Rand and West Rand Groups in a semicircle around the dome. Ancient rocks of the Blackreef Formation (quartzite, conglomerate, shale and basalt) and the Malmani Subgroup (dolerites and cherts) have been similarly affected (Robb et al., 2006; McCarthy et al., 2006; van der Westhuizen et al., 2006). The Malmani Subgroup is up to 2000m thick and comprises five formations distinguished by the amount of chert, stromatolite morphology, intercalated shales and erosion surfaces (Eriksson et al., 2006). The basal Oaktree Fm overlies the Black Reef Formation, and is made up of carbonaceous shales, stromatolitic dolomites and locally developed quartzites. Above this is the Monte Christo Formation comprising erosive breccia, overlain by stromatolitic and oolitic platformal dolomites. Next is the Lyttleton Formation of shales quartzites and stromatolitic dolomites. The Eccles Formation comprises a series of erosional breccias and the overlying Frisco Formation is made up mostly of stromatolitic dolomites.

The Klipriviersberg Group is composed of a sequence of mafic lavas and tuffs with amygdaloidal and porphyritic inclusions in varying amounts, separating the five formations, from the base upwards, Alberton, Orkney, Jeanette, Lorraine and Edenvale Formations (van der Westhuizen et al., 2006), dated to around 2700 Ma.

The other rocks in the region would not be affected by this development and will not be discussed further.

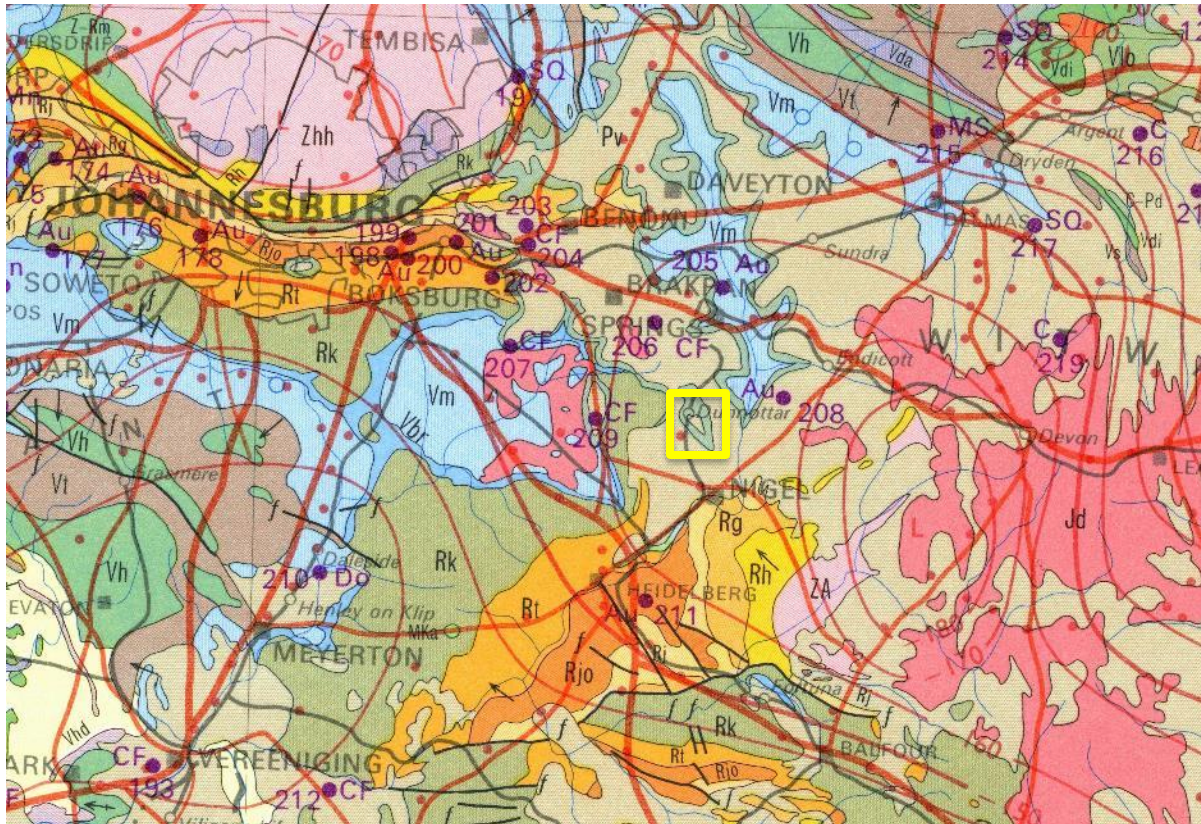


Figure 2: Geological map of the area around Nigel and Dunnottar. The KwaThema to Grundligh bulk Sewer supply pipeline project is within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 0

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

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 25 Ma to present
Jd	Jurassic dykes	Dolerite	Jurassic ca 183 Ma
Pv	Vryheid Formation, Ecca Group, Karoo Supergroup	Sandstone, shale, coal	Early Permian, middle Ecca
Vt	Timeball Hill Fm and Rooihoogte Fm, Pretoria Group, Ventersdorp SG	Quartzite	< 2420 Ma
Vbr	Black Reef Fm,	Quartzite, conglomerate, shale, basalt	Ca 2650 – 2640 Ma
Vm	Malmani Subgroup, Chuniespoort Group, Transvaal Basin	Dolomite, chert	Ca 2750 – 2650 Ma
Rk	Klipriviersberg Group, Ventersdorp SG	Andesite, tuff	Ca 2714 Ma
Rt	Turfontein Subgroup, Central Rand Group, Witwatersrand SG	Conglomerate, quartzite	Ca 2750 Ma
Rjo	Johannesburg Subgroup, Central Rand Group, Witwatersrand SG	Quartzite, conglomerate, shale	
Rj	Jeppestown Subgroup, West Rand Group, Witwatersrand SG	Shale, quartzite, lava	
Rg	Government Subgroup, West Rand Group, Witwatersrand SG	Quartzite, shale	
Rh	Hospital Hill Subgroup, West Rand Group, Witwatersrand SG	Shale quartzite	Ca 2950 Ma
ZA	Granite, gneiss, Vredefort Dome	Granite, gneiss	Ca 3100 Ma



### 3.2. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. In the central part of the greater project area the Klipriviersberg Group mafic lavas and tuffs do not preserve fossils as they are too old for body fossils and are volcanic in origin. These rocks are indicated as blue in the map (low sensitivity).

Around the central area are rocks of the Malmani Group that may preserve trace fossils. The Malmani Group contains a number of stromatolitic dolomites. These were formed in warm shallow sea and are the accumulation of layer upon layer of minerals deposited by blue-green algae (also known as cyanobacteria) and rarely some filamentous algae. Minerals deposited by the algae include calcium carbonate, calcium sulphate and magnesium carbonate. Very rarely are the algal cells preserved in the stromatolites and these are microscopic. Stromatolites are essentially trace fossils and these ones are 2750 to 2650 million years old and very abundant. They can appear as small to large domes (few cm in diameter to 1-2m) or as irregular stratified sheets, depending on the conditions under which they formed over 2600 million years ago.

Around the periphery of the project area are sandstones and shales of the Vryheid Formation of the Ecca Group, early Permian and these could potentially preserve fossil plants of the Glossopteris flora. The Glossopteris flora formed coal deposits in part of the Karoo Basin and the plants include Glossopteris predominantly in the form of leaf impressions, as well as coriataleans, lycopods, sphenophytes, ferns and rare gymnosperms (Plumstead, 1969; Anderson and Anderson, 1985; Johnson et al., 2006). Terrestrial vertebrate fossils are not present in this area at this time.

From the SAHRIS map above the proposed only the pipeline in the south west branch and the very distal ends of the two northern pipelines are indicated as highly sensitive (red). The rest of the pipeline falls on moderately sensitive rocks in the north (green) and low to insignificant sensitivity in the south section (Figure 3). No fossils however, however, have been recorded from this area and the land surface is highly disturbed from earlier agricultural and current urban activities.

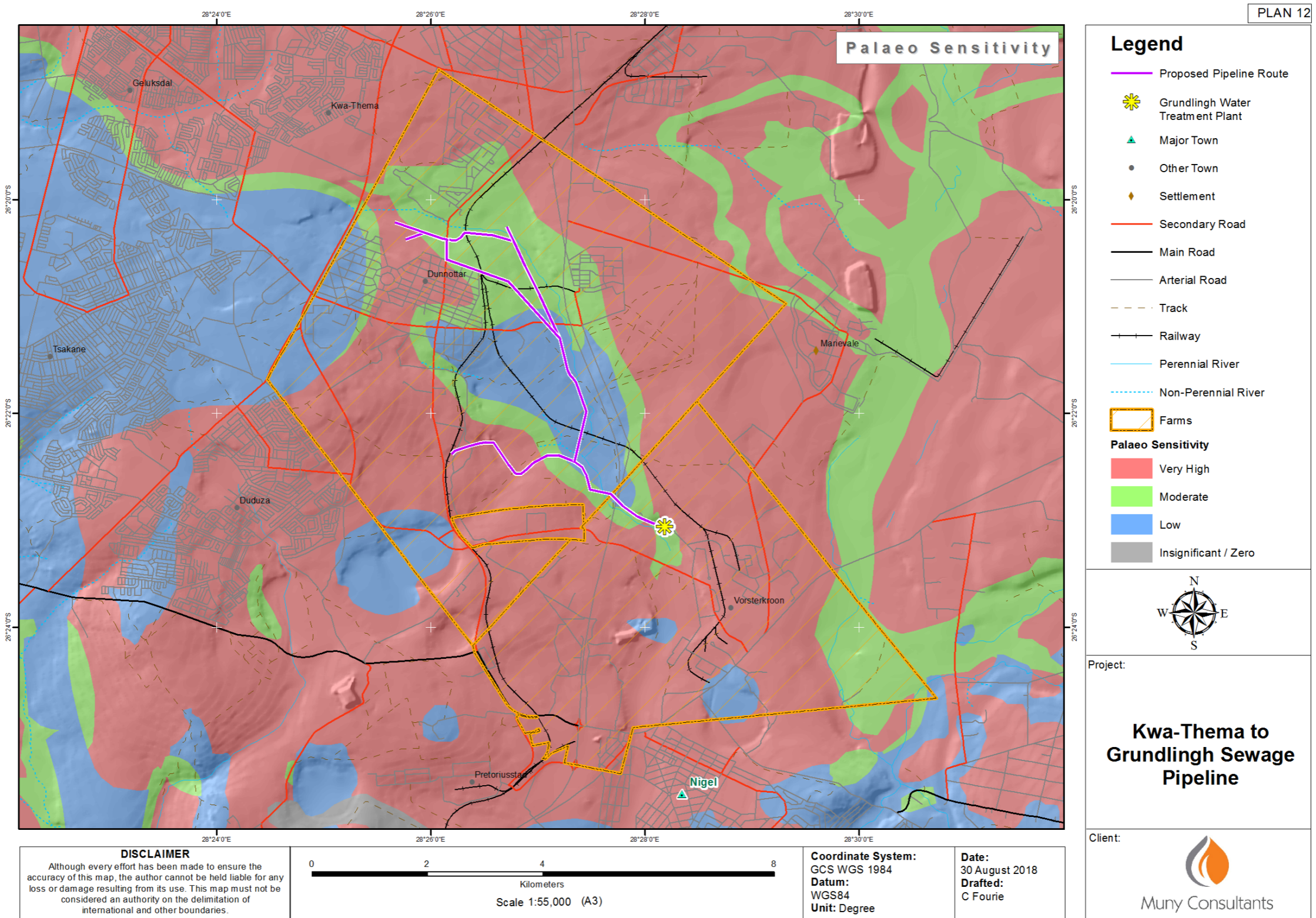


Figure 3: SAHRIS palaeo-Sensitivity maps for the site for the proposed KwaThema to Grundlignh project. (Map supplied by Muny Consultants)

#### 4. IMPACT ASSESSMENT

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in **Error! Reference source not found.** and 4.

Table 3: Criteria for assessing impacts

<b>PART A: DEFINITION AND CRITERIA</b>		
<b>Criteria for ranking of the SEVERITY/NATURE of environmental impacts</b>	<b>H</b>	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	<b>M</b>	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	<b>L</b>	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	<b>L+</b>	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	<b>M+</b>	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	<b>H+</b>	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
<b>Criteria for ranking the DURATION of impacts</b>	<b>L</b>	Quickly reversible. Less than the project life. Short term
	<b>M</b>	Reversible over time. Life of the project. Medium term
	<b>H</b>	Permanent. Beyond closure. Long term.
<b>Criteria for ranking the SPATIAL SCALE of impacts</b>	<b>L</b>	Localised - Within the site boundary.
	<b>M</b>	Fairly widespread – Beyond the site boundary. Local
	<b>H</b>	Widespread – Far beyond site boundary. Regional/ national
<b>PROBABILITY (of exposure to impacts)</b>	<b>H</b>	Definite/ Continuous
	<b>M</b>	Possible/ frequent
	<b>L</b>	Unlikely/ seldom

Table 4: Impact Assessment

<b>PART B: Assessment</b>		
<b>SEVERITY/NATURE</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	The Vryheid Fm could preserve impression fossils of the <i>Glossopteris</i> flora. Stromatolites (Malmani Group) are trace fossils and only rarely preserve the filamentous green algae or the cynaobacteria or bluegreen algae that formed them. It is very unlikely that fossils occur on the site. The impact would be very unlikely.
	<b>L+</b>	-
	<b>M+</b>	-
	<b>H+</b>	-
	<b>DURATION</b>	<b>L</b>
<b>M</b>		-
<b>H</b>		Where manifest, the impact will be permanent.
<b>SPATIAL SCALE</b>	<b>L</b>	Since only the possible fossils within the area would be microscopic algae in the stromatolites, the spatial scale will be localised within the site boundary.
	<b>M</b>	<i>Glossopteris</i> fossils might occur along the south western pipeline.
	<b>H</b>	-
<b>PROBABILITY</b>	<b>H</b>	-
	<b>M</b>	-
	<b>L</b>	There is a very small chance that Vryheid Fm fossils ( <i>Glossopteris</i> ) occur on the surface and a few metres below surface. It is extremely unlikely that any fossils would be found in the stromatolites that may overlie the area to be excavated. Nonetheless a chance find protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities are unlikely to impact upon the fossil heritage if preserved in the development footprint because of previous disturbance. Once excavations for the pipelines commence, Vryheid Formation fossils might be discovered along the southwestern section. The geological structures suggest that the rest of the rocks are either much too old to contain fossils or contain only trace fossils, i.e. stromatolites. Since there is a very small chance that fossils from the Vryheid Formation may be disturbed a 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 dolomites, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The sandstones and shales of the Vryheid Formation might contain fossils of the *Glossopteris* flora, but none has been recorded from this site

## **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 stromatolites of the Malmani Subgroup. Since there is a small chance that plant fossils may occur below the land surface a 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: Prodrumus of South African megaflores, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Eriksson, P.G., Altermann, W., Hartzler, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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 237-260.

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.

Robb, L.J., Brandl, G., Anhaeusser, C.R., Poujol, M., 2006. Archaean Granitoid Intrusions. 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 57-94.

Van der Westhuizen, W.A., de Bruijn, H., Meintjes, P.G., 2006. The Ventersdorp 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 187-208.

## 8. CHANCE FIND PROTOCOL

### **Monitoring Programme for Palaeontology – to commence once the excavations for pipelines begins.**

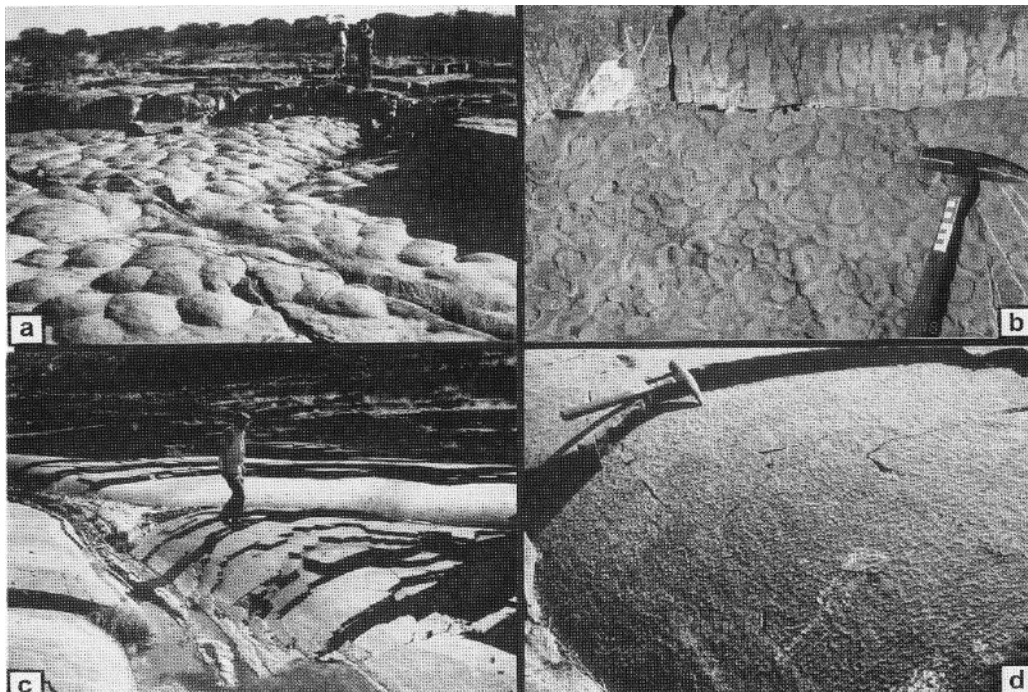
1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (algae, plants, insects, bone, coal) should 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. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.



## 9. APPENDIX A – EXAMPLES OF STROMATOLITES



*Figure 3: Small domal stromatolites from the Malmani Subgroup. Ruler is 12cm long.*

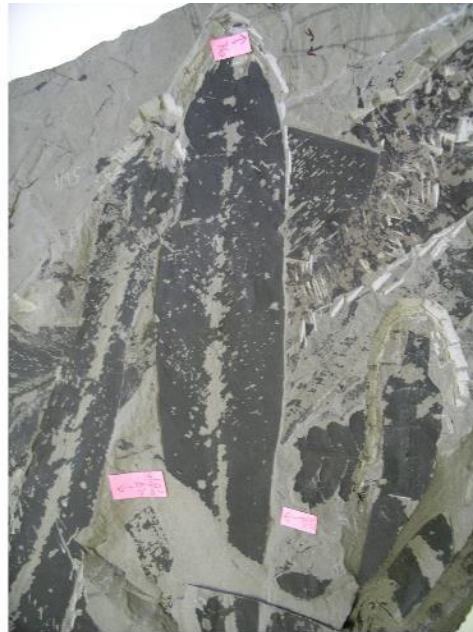


*Figure 4: Large stromatolites. (From Erikssen et al., 2006.)*





Wide and narrow Glossopteris leaves



Narrow Glossopteris leaves



Lycopod stem with leaf abscission scars



Astertothea (fern)

### Hamanskraal fossil plants

Figure 5: Impressions and compressions (with cuticle) of leaves from the *Glossopteris* flora

## 10. APPENDIX B – DETAILS OF SPECIALIST

### Curriculum vitae (short) - Marion Bamford PhD

October 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  
Fax : +27 11 717 6694  
Cell : 082 555 6937  
E-mail : [marion.bamford@wits.ac.za](mailto:marion.bamford@wits.ac.za) ; [marionbamford12@gmail.com](mailto: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

#### **xi) Research Output**

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 28;

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)