# Palaeontological Impact Assessment for the proposed Sonvanger Overhead Transmission Line, Theunissen, Free State Province

**Desktop Study (Phase 1)**

**For**

**CTS Heritage**

**25 July 2021**

**Prof Marion Bamford**
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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 CTS Heritage, Cape Town, 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 realignment of the Sonvanger 132 kV Overhead transmission Line between the Sonvanger Photo Voltaic Facility southwest of Theunissen northwards along the R30 road to the Beatrix Mine Sibanye Stillwater. The project is in the Free State 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) was completed for the proposed development.

The proposed site route in the northern section lies on the Quaternary sands, alluvium and calcretes that are non-fossiliferous unless there are traps for fossils such as paleo-pans or palaeo-springs. No such feature is visible on the satellite imagery. The southern half is on non-fossiliferous dolerite of Jurassic age. 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 when excavations for foundations commence.

# Table of Contents

# 1. Background

This application is for the proposed development of a power line that runs along the road reserve of the R30 from the Sonvanger PV facility located just outside of the town of Theunissen until the Beatrix Mine Sibanye Stillwater located approximately 18km northeast of Theunissen. The activity entails the development of a 132kV single-circuit power line to enable the connection of the authorised Sonvanger Photovoltaic Solar Power Plant (DFFE ref.: 14/12/16/3/3/2/672) to the national grid network. This will enable the evacuation of the generated solar electricity. A 200m wide and 22km long grid connection corridor is being assessed for the placement of the power line route. The power line is proposed to connect into the existing Oryx-Joel 132kV Line. A service road associated with the power line is also proposed to be developed.

The farms along the route are: Afrikander Oord 80 (Portions 0 & 2), Ebenhaeser 401 (Portions 0, 1, 2 and 3), Erfbloem 12 (Portions 0, 4, 5 and 6), Excelsior 147 (Portions 1, 2 and 3), Geodemoed 143 (Portions 0, 2 and 3), Grottkau 410 (Portions 0, 3 and 5), Karreebooms Vallei (Portions 0, 2, 5, 6, 7 and 8), Leeuwbult 52 (Portions 0 and 3), Leeuwvlei 115 (Portions 0, 1, 2 and 3), Mamre 566 (Portions 0, 1, 2 and 3), Masilo 597 (Portions 0 and 12), Mooi Hoek 297 (Portions 0, 1, 4 and 5), Silesia 409 (Portions 0, 2 and 3), Smaldeel 262 (Portions 0, 1, 2, 8, 20, 21, 22, 23), Spes Bona 290 (Portions 0 and 2), Theunissen 252 (Portions 0 and 2), Vergelegen 85 (Portions 1, 4, 5 and 7). They fall in the Masilonyana and the Matjhabeng Local Municipalities, of the Lejweleputswa District Municipality, Province Free State Province

The proposed alignment of the power line will be located along an existing regional road, the R30, it is not anticipated that this proposed development will negatively impact on any significant palaeontological resources

A Palaeontological Impact Assessment was requested for the project. 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 presented 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 |

| | | |
|---|---|---|
| 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 |

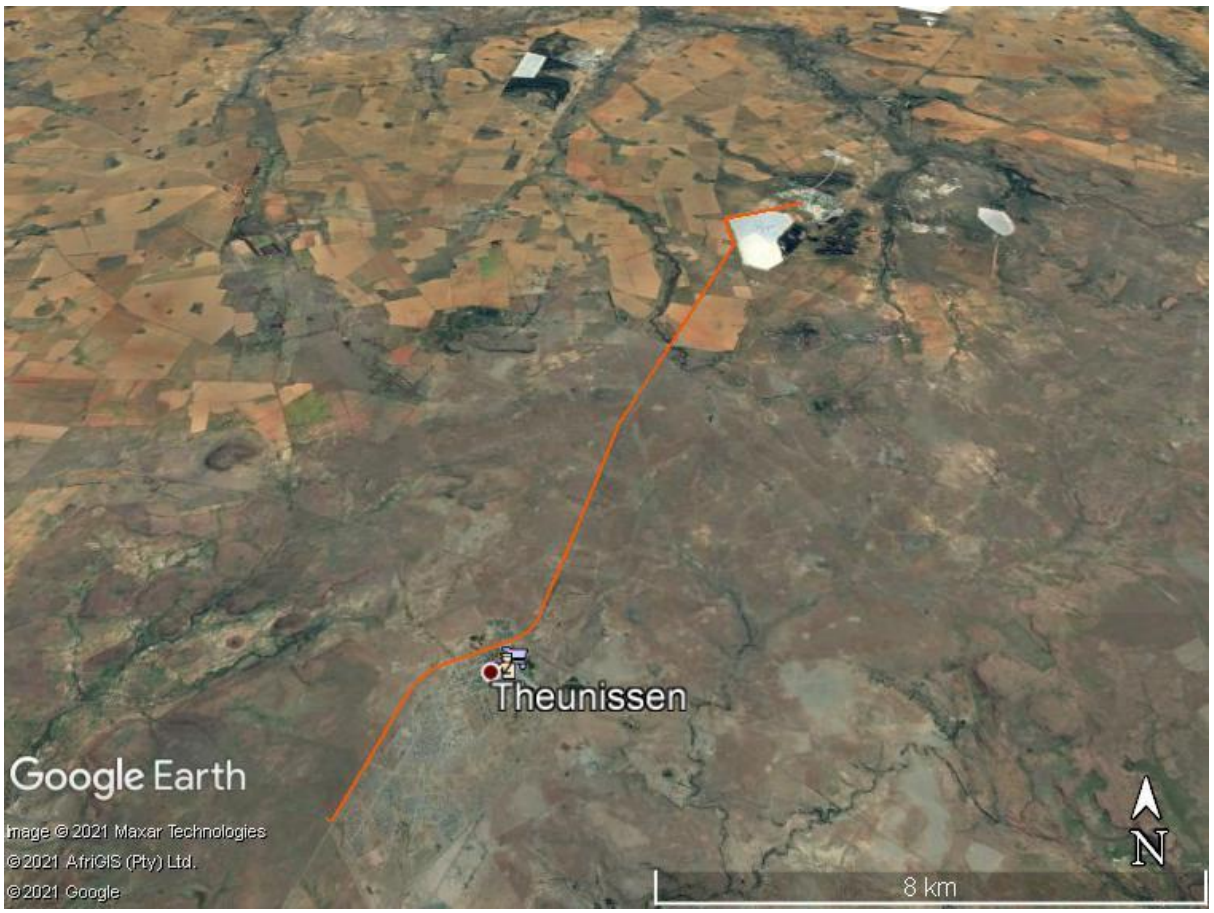


Figure 1: Google Earth map of the route of the Sonvanger OHL alongside the R30, from Beatrix Mine in the North to Sonvanger PV facility southwest of Theunissen. Map supplied by CTS Heritage.

## 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

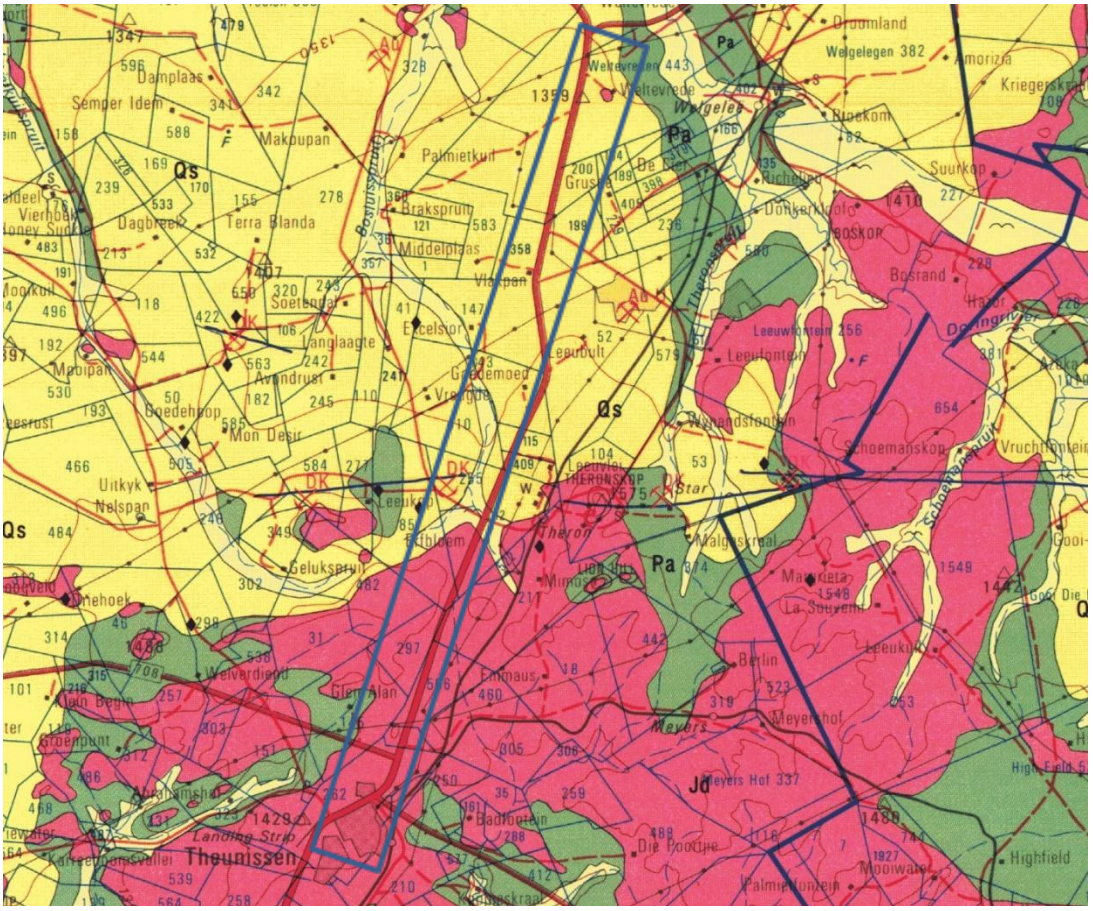


Figure 2: Geological map of the area north of Theunissen with the Sonvanger OHL indicated within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2826 Winberg.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006; Smith et al., 2020). SG = Supergroup; Fm = Formation; Ma = million years; AZ = vertebrate Assemblage Zone; grey shading = formations impacted by the project.

| Symbol | Group/Formation | Lithology | Approximate Age |
|---|---|---|---|
| Qs | Quaternary | Alluvium, sand, calcrete | Neogene, ca 2.5 Ma to present |
| Jd | Jurassic dykes | Dolerite dykes, intrusive | Jurassic, approx. 180 Ma |
| Pa | Adelaide Subgroup, Beaufort Group, Karoo SG | Mudstones, sandstone, thin cherty beds | Late Permian, Early Beaufort |

The route is in the central part of the Main Karoo Basin, east of the line of latitude 24°E that is important for the stratigraphy of the Karoo Basin (Rubidge (Ed)., 1995). These old rocks are unconformably overlain by Quaternary sands and alluvium (Figure 2).

The Main Karoo Basin covers a large proportion of South Africa and represents some 120 million years of deposition. At the base is the Carboniferous-Permian Dwyka Group, then the Permian aged Ecca Group, Permian-Triassic Beaufort Group, the Triassic-Jurassic Stormberg Group, all capped by the Drakensberg basalts.

Two subgroups are recognised in the Beaufort Group, the lower Adelaide Subgroup and the upper Tarkastad Subgroup. There are six formations in the Adelaide Subgroup but their distribution is not the same throughout the basin. West of the 24°E line of latitude the rocks have been divided in the basal Abrahamskraal Formation, the upper Teekloof Formation and no younger rocks. East of the 24°E line of latitude there are three formations: the basal Koonap Formation, Middleton Formation and the Balfour Formation. Five members are noted in the Balfour Formation, from the base upwards: Oudeberg Member, Daggaboersnek Member, Barberskrans Member, Elandsberg Member and Palingkloof Member. In the Free State and KwaZulu Natal upper Beaufort, only one formation is usually recognised, the Normandien Formation (previously known as the Estcourt Formation; Anderson and Anderson, 1985).

Intruding through the Karoo rocks are volcanic dykes of Jurassic age and they were emplaced when the major Drakensberg basalts poured out and capped the Karoo sediments. These dolerite dykes are common in the area and because they are harder than the Karoo sediments they form ridges and hills.

The OHL route is also on the Quaternary sands, alluvium and calcrete that have covered the underlying rocks during the Quaternary. The depth of the overlying sands, however, is unknown.

## ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 3 and 4. The OHL route is on non-fossiliferous Jurassic dolerite in the southern part around Theunissen (Figure 3), and in the northern section it is on the Quaternary sands, alluvium and calcrete (green on the SAHRIS map; Figure 4). They are considered to be moderately sensitive for palaeontology.

According to the revised biostratigraphy for the Beaufort (Smith at al., 2020), Theunissen is probably in the Daptocephalus vertebrate Assemblage Zone but around the town the dolerite has intruded through them.

Dolerite is an intrusive volcanic rock so does not preserve fossils. In fact it tends to destroy fossils in its immediate vicinity.

Quaternary calcretes and sands may preserve fragments of transported bone, wood, rhizoliths and invertebrate shells but these would be out of context and very small. Only under special conditions such as palaeo-pans and palaeo-springs would younger and more complete fossils be likely to form or be trapped. These would include Quaternary aged plants, wood, mammals, rodents and invertebrates (Partridge et al., 2006; Goudie and Wells, 1995). Pans do occur in this arid region of central South Africa (Goudie and Wells, 1995, Fig. 2) but none can be seen in the satellite imagery. Furthermore, the route is already disturbed from the agricultural activities and the existing road and powerline.

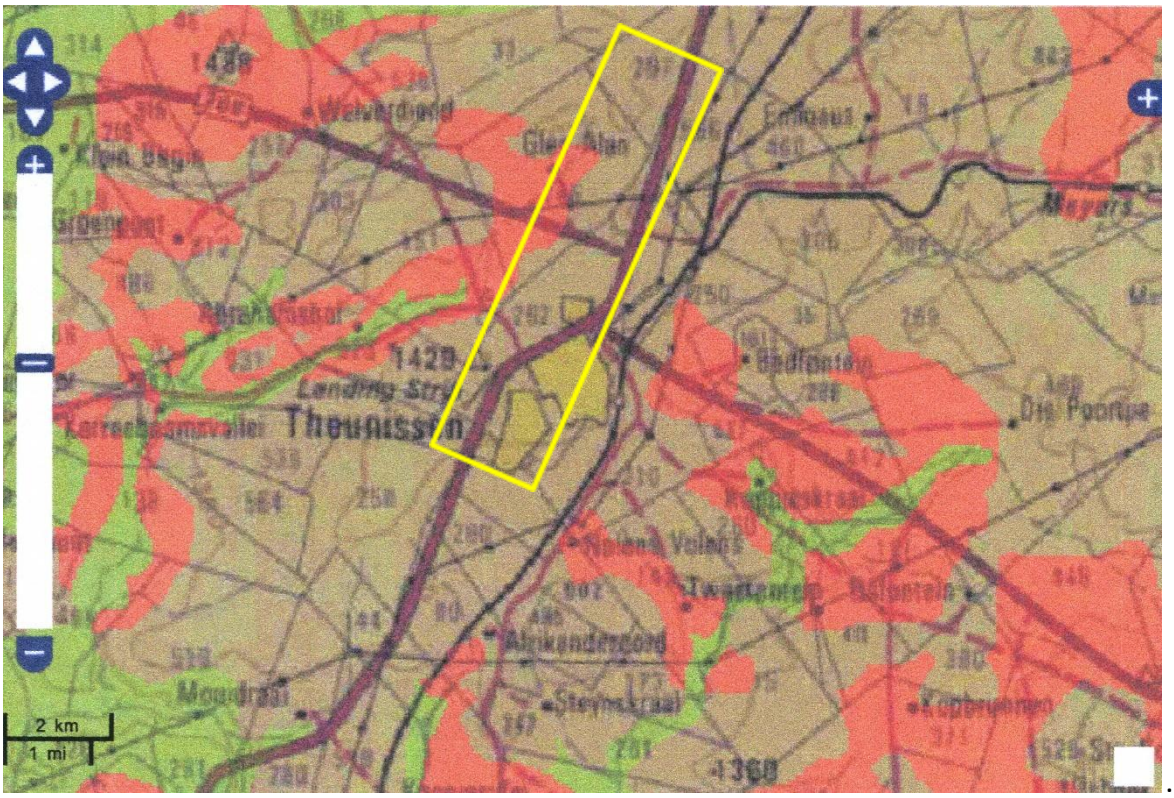


Figure 3: SAHRIS palaeosensitivity map for southern part of the route for the proposed Sonvanger OHL realignment, shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Brink (no date) noted that the Modder River is very fossiliferous but the river is some distance from the OHL route so not associated with palaeo-channels or bank deposits.

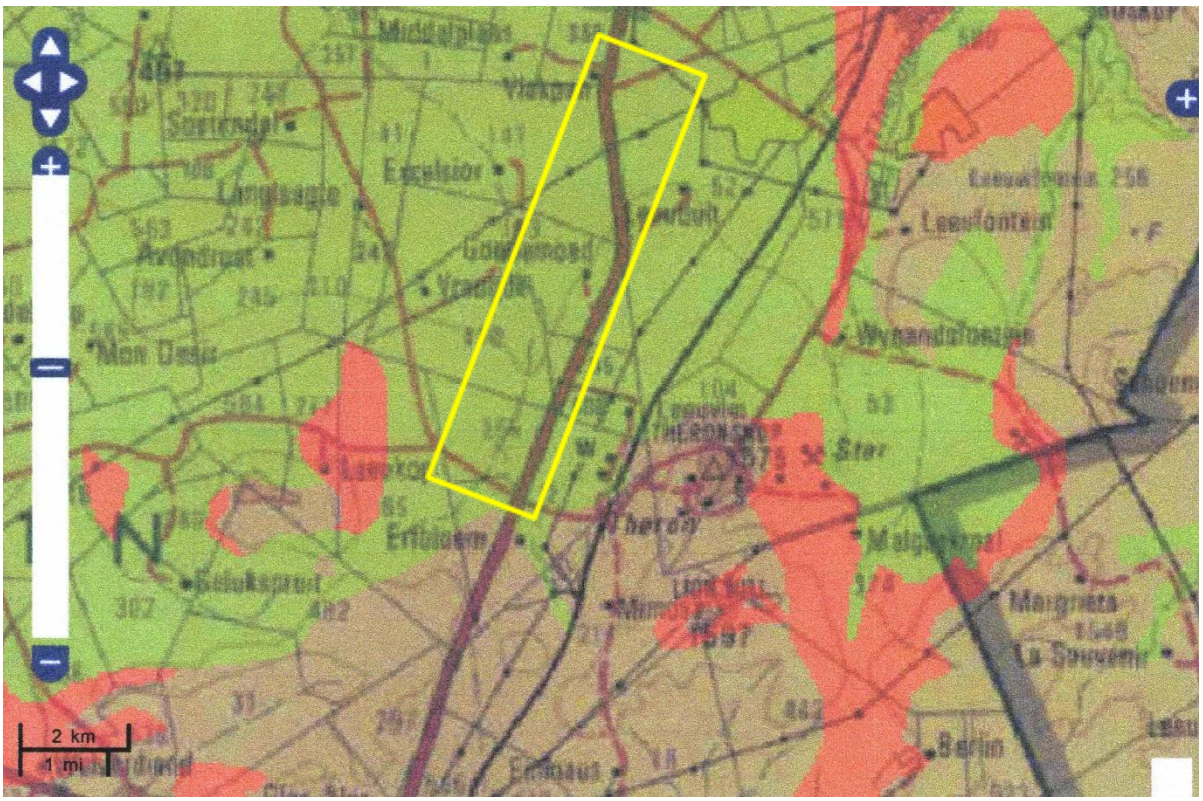


Figure 4: SAHRIS palaeosensitivity map for northern section of the route for the Sonvanger OHL where it goes along the R30 and around the west side of the Beatrix mine, shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = 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** | Quaternary calcretes only preserve fossils in palaeo-pans or palaeo-springs; so far there are no records from the site. 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 the only possible fossils within the area would be fossil wood or bones from the Quaternary in palaeo-pans or palaeo-springs, the spatial scale will be localised within the site boundary. |
| | **M** | - |
| | **H** | - |
| **PROBABILITY** | **H** | **-** |
| | **M** | **-** |
| | **L** | It is extremely unlikely that any fossils would be found in the loose sand that occurs along the route or in the calcretes (no pans or springs are visible).. 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 much too young and are transported so unlikey to contain fossils. Furthermore, the excavations for foundations are not expected to be very deep. Since there is an extremely small chance that fossils 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 mudstones, sandstones, shales, calcretes and sands are typical for the country and might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. It is not known how thick are the sands but the route is along a road servitude and there are already poles in place.

# 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 sands, alluvium and calcretes of the Quaternary. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations for the foundations for the PV facility and amenities 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.

Brink, J.S., (no date). A palaeontological desktop study of the areas to be affected by the proposed Solar Power Plants near Bloemfontein and near Theunissen, Free State Province.

Goudie, A.S., Wells, G.L., 1995. The nature, distribution and formation of pans in arid zones. Earth Science Reviews 38, 1-69.

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.

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.

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 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 5-7). 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 fluvial and pan deposits

Figure 6: Examples of bone fragments from a palaeo-pan in the Quaternary sands and calcrete.


Figure 6: silicified wood from a Quaternary fluvial deposit, scale = 15 cm.

## 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)