Palaeontological Impact Assessment for the proposed Boruthro – Silimela 400 kV OHPL strengthening project, Limpopo Province

Desktop Study (Phase 1)

For

NTC Group (Pty) Ltd

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Expertise of Specialist

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27 years PIA studies and over 350 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by NTC Group (Pty) Ltd, Bryanston, 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

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Executive Summary

A Palaeontological Impact Assessment was requested for the emergency upgrade of the 400 kV powerline from the Eskom Boruthro Substation, north of Sekurure, 165 km southwards to Silimela Substation, south of Marble Hall, Limpopo Province. Several minor deviations have been included since the conception of the project BUT are included in the broad zones assessed for the palaeontology.

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.

The proposed route mostly lies on non-fossiliferous to moderately fossiliferous rocks of the Ventersdorp, Transvaal and Karoo Supergroups. Two short sections lie on very highly sensitive rocks, namely on the Malmani Subgroup dolomites in the northern section on Farm Rietfontein 2; and in the southern section on Irrigassie Formation shales on Farms Doringstock 623 and Rondeberg 624. These sections are already disturbed but a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations, drilling or mining activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	High to Zero	Very Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

Table of Contents

1. Background

ESKOM has appointment NTC Group for Basic Assessment process for Highveld North-West and Lowveld Strengthening Project (Borutho-Silimela) 400 KV power line and associated infrastructure, in Limpopo Province. The line is approximately 165km long.

The powerline route is from Boruthro Substation, northeast of Serurwe at 23° 54' 10.84" S and 28° 58' 38.12" E in the north, and goes southwards and along the eastern side of Mokopane, south to the southern side of Marble Hall to Silimela Substation at 25° 05' 12.80" S and 29° 17' 51.87" E. A 100m wide corridor is also under consideration (Figures 1-2). For this report, the route has been divided into four portions, from north to south, simply for reasons of scale for the relevant geological and palaeosensitivity maps, and not related to the Eskom structures (Table 1).

Table 1: Sections for ease of description for this report only.

		Figure numbers for maps			
Section	Route of 400kV line	Route	Geology	Palaeontology	Highly sensitive
1	Boruthro SS to Mokopane	2	3	7	8
2	Mokopane to Roedtan	2	4	7	
3	Roedtan to Marble Hall	2	5	7	9
4	Marble Hall to Silimela SS	2	6	7	

The route is more or less from north to south but with deviations around the towns and also to accommodate some specific requests for power. Mostly the route is adjacent to the existing powerline, or along road servitudes or farm borders (Figure 1).

A Palaeontological Impact Assessment was requested for the Boruthro – Silimela 400kV powerline 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 reported herein.

Table 2: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6). Includes the requirements from GNR Appendix 6 of GN 326 EIA Regulation 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 specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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 8, 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 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
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	Sections 6, 8
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 of any comments that were received during any consultation process	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

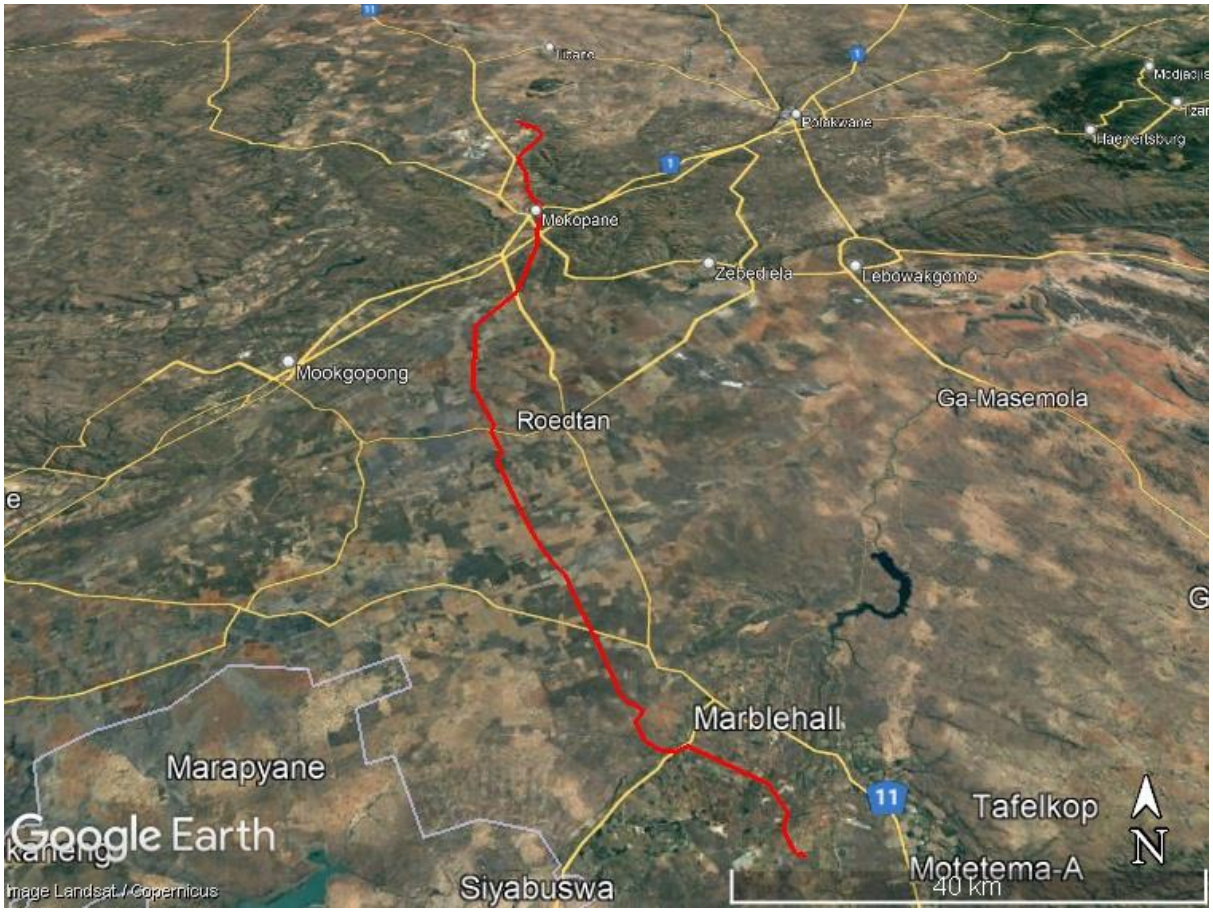

Figure 1: Google Earth map of the general area to show the relative towns and landmarks for the Boruthro (north) to Silimela (south) 400kV powerline, shown by the red line.

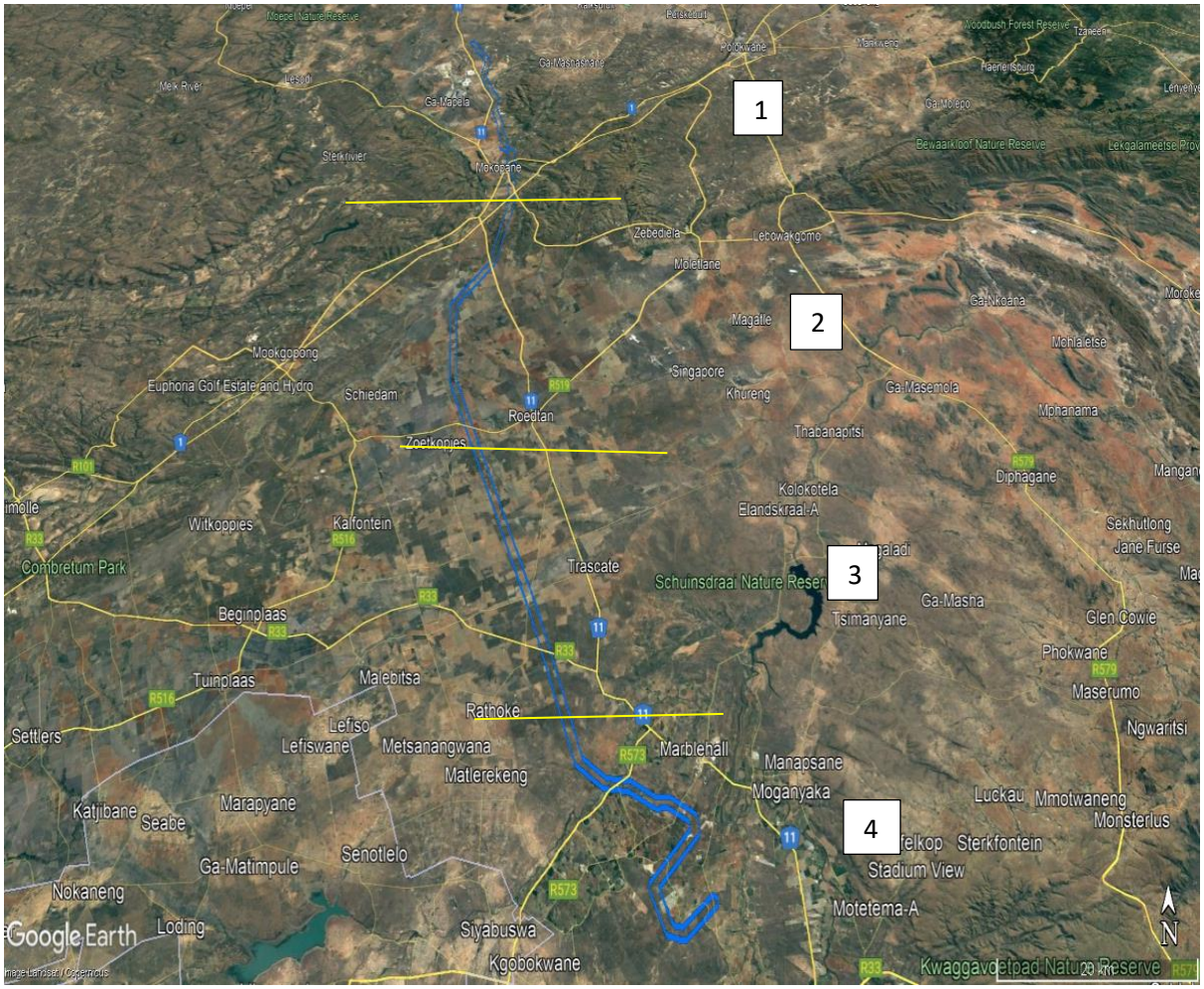

Figure 2: Google Earth Map of the proposed corridor for the Boruthro-Silimela 400 kV powerline (blue lines). Sections (for this report only) indicated as 1-4 (see table 1).

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 include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases; eg https://sahris.sahra.org.za/map/palaeo
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' representativity 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

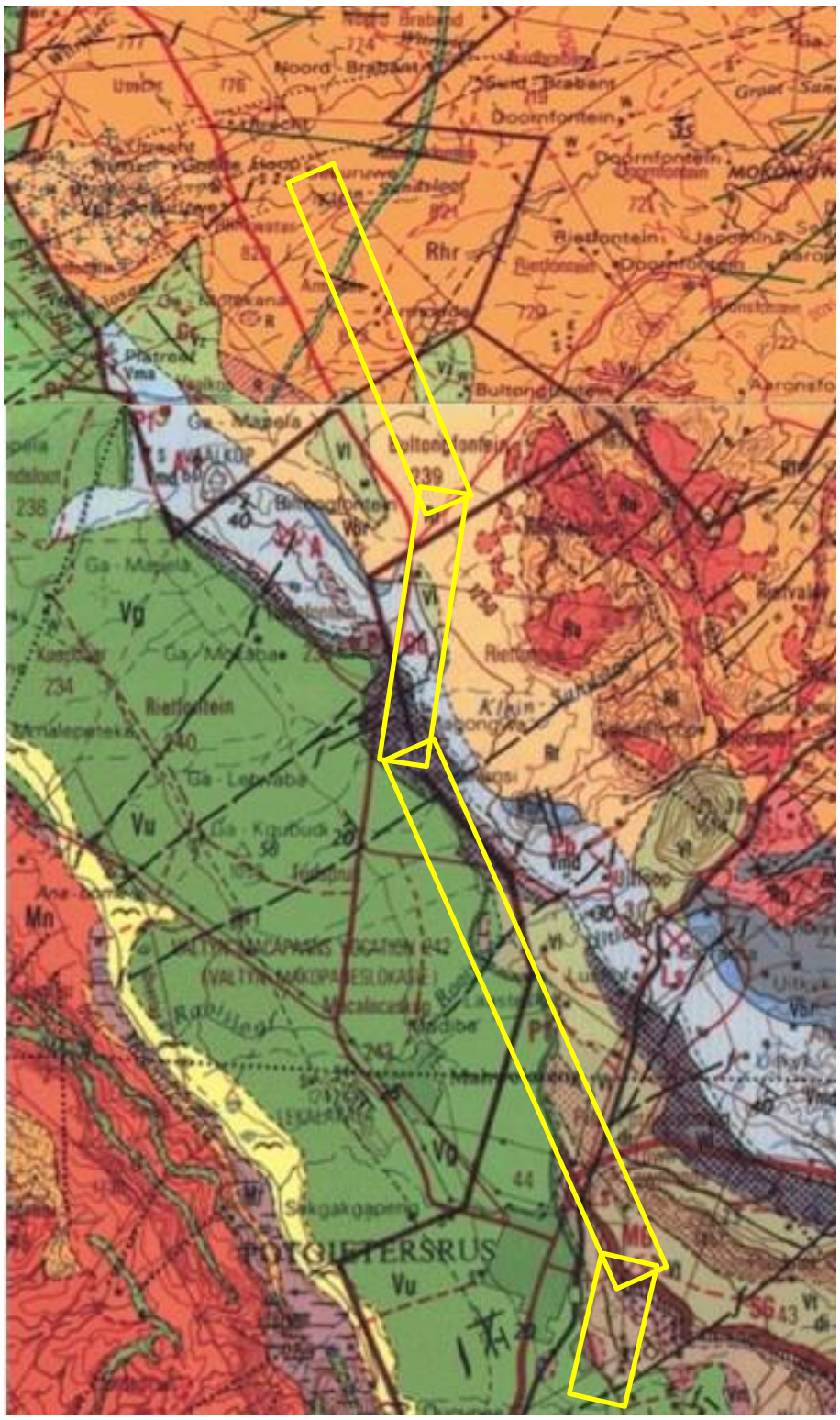

Figure 3: Geological map of the area around the northern route (Section 1) of the Boruthro-Silimela Powerline. The proposed route is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2328 Polokwane (top) and 2428 Nylstroom (bottom)

Table 3: Explanation of symbols for the geological maps (all four) and approximate ages (Eriksson et al., 2006; Johnson et al., 2006; McCarthy et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Quaternary ca 1.0 Ma to present
Jd	Jurassic dolerite	Dolerite	Jurassic Ca 183 Ma
Tr	Clarens Fm, Stormberg Group, Karoo SG	Sandstone, dunes	Late Triassic
P-Tr	Irrigassie Fm, Ellisras Basin, Karoo SG	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pe	Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca
C-Pd	Dwyka Group, Karoo SG	Tillites, diamictite, sandstone, mudstone	Late Carboniferous to Early Permian
Mn	Nebo Granite	Granite	Palaeoproterozoic
Vu	Upper Zone, Rustenburg Layered Suite, Bushveld Igneous Complex	Gabbro, norite, pyroxenite, anorthosite, etc	Ca 2055 Ma
Vg	Main Zone, Rustenburg Layered Suite, Bushveld Igneous complex	Gabbro, norite, pyroxenite, anorthosite, etc	Ca 2055 Ma
Vl	Lower Zone, Rustenburg Layered Suite, Bushveld Igneous Complex	Gabbro, norite, pyroxenite, anorthosite, etc	Ca 2055 Ma
Vm	Magaliesberg Fm, Pretoria Group, Transvaal SG	Quartzite, minor hornfels	<2080 Ma
Vsi	Silverton Fm, Pretoria Group, Transvaal SG	Shale, carbonaceous in places, hornfels, chert	Ca 2202 Ma
Vdq	Daspoort Fm, Pretoria Group, Transvaal SG	Quartzite	<2240 Ma
Vst	Strubenkop Fm, Pretoria Group, Transvaal SG	Shale, in places ferruginous	Ca 2242 Ma
Vdw	Dwaalheuvel Fm, Pretoria Group, Transvaal SG	Quartzite, chert, jaspilite	<2242 Ma
Vha	Hekpoort Fm, Pretoria Group, Transvaal SG	Volcanic rocks	Ca 2224 Ma
Vb	Boshoek Fm, Pretoria Group, Transvaal SG	Quartzite	Ca 2266 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vt	Timeball Hill Fm Pretoria Group, Transvaal SG	Shale, siltstone, conglomerate in places; dotted = Quartzite	Ca 2316 – 2266 Ma
Vd	Duitschland Fm, Chuniespoort Group, Transvaal SG	Conglomerate	<2343 Ma
Vp	Penge Fm, Chuniespoort Gr, Transvaal SG	Banded ironstone	Ca 2480 Ma
Vmd	Malmani SG, Chuniespoort Group, Transvaal SG	Dolomite, chert	Ca 2585 – 2480 Ma
Vbr	Black Reef Fm, Transvaal SG	Quartzite, conglomerate, shale	<2618 Ma
Vde	Dennelton Fm, Groblersdal Group	Granophyric gneiss	>2618 Ma
Ru	Uitloop Granite, Mashashane Suite	Granite	Ca 2687 Ma
Rl	Lunsklip Granite, Mashashane Suite	Granite	Ca 2777 Ma
Rt	Turfloop Granite	Granite, biotite granite	Ca 2777 Ma
Z	Unnamed basement granites	Granite	>3000 Ma

The power line route crosses a number of ancient basins and their related rock sequences. This section provides an overview of the geology of the whole route, from oldest to youngest (not following any direction). Then the palaeontology is described for all the rocks. In the following section the rocks along the route are described, as divided into the four sections for ease of map scales and legibility(Figures 3-6).

The Archaean granitoid intrusions occur mostly in the north and northeast of the Kaapvaal Craton and have been divided into several groups based on the timing of the intrusions (Robb et al., 2006). Three of these granitoids occur in the northern part of the project area and are Neoarchaean intrusions (2800 – 2500Ma) and are associated with the Pietersburg and Giyani Greenstone Belts. The Turfloop Granite is an elongate northeast-trending batholith whose composition ranges from granodiorite to monzogranite. The Uitloop and Linsklip Granites of the Mashashane Suite intruded through the Goudplaats-Goud River Gneiss. A much younger and unrelated granite, the Nebo Granite of the Lebowa Suite, occurs to the west of Mokopane (Figure 3) and north, west and east of Marble Hall (Figure 6).

Part of the route lies in the Transvaal Basin that has exposures of the basal members of the Transvaal Supergroup, and overlies the older rocks of the Witwatersrand Supergroup. Unconformably overlying the Transvaal Supergroup rocks are the much younger basal members of the Karoo Supergroup as this is the northern margin of the Main Karoo Basin. Along the rivers and watercourses are recent deposits of sand and alluvium, of late Quaternary age (Figures 5-6).

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal **Malmani Subgroup** that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the **Duitschland Formation**. The Pretoria Group represents another two cycles of deposition. Making up the lower Pretoria Group are the Timeball Hill Formation and the Boshoek Formation. The Hekpoort, Dwaalheuwel, Strubenkop and Daspoort Formations form a sequence as the middle part of the Pretoria Group, Transvaal Supergroup, and represent rocks that are over 2060 million years old. The Hekpoort Formation is a massive lava deposit and is overlain by the Dwaalheuwel conglomerates, siltstone and sandstone (not present here). A hiatus separates the Strubenkop Formation slates and shales from the overlying quartzites of the Daspoort Formation. Upper Pretoria Group formations are the Silverton, Magaliesberg, Vermont, Lakenvalei, Nederhorst, Steenkampsberg and Houtenbek Formations

Transvaal Supergroup rocks in the Transvaal Basin were intruded by the Bushveld Complex at around 2060 million years ago (Eriksson et al. 2006; 2055 Ma in Zeh et al., 2020), with the Magaliesberg Formation of the Pretoria Group forming the floor rocks in most areas (Eriksson et al., 2006). In other areas of the basin the lavas and other subordinate sedimentary rocks of the Rooiberg Group form the floor instead (ibid).

The **Karoo Supergroup** rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest 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.

Overlying the basal glacigene 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 Limpopo the Springbok Flats Basin has only four recognisable formations, the basal Dwyka Group, the Hammanskraal Formation (equivalent to the Vryheid Formation and lower Volksrust Formation), the **Irrigassie Formation** (possibly equivalent to the Beaufort Group) and the **Clarens Formation**.

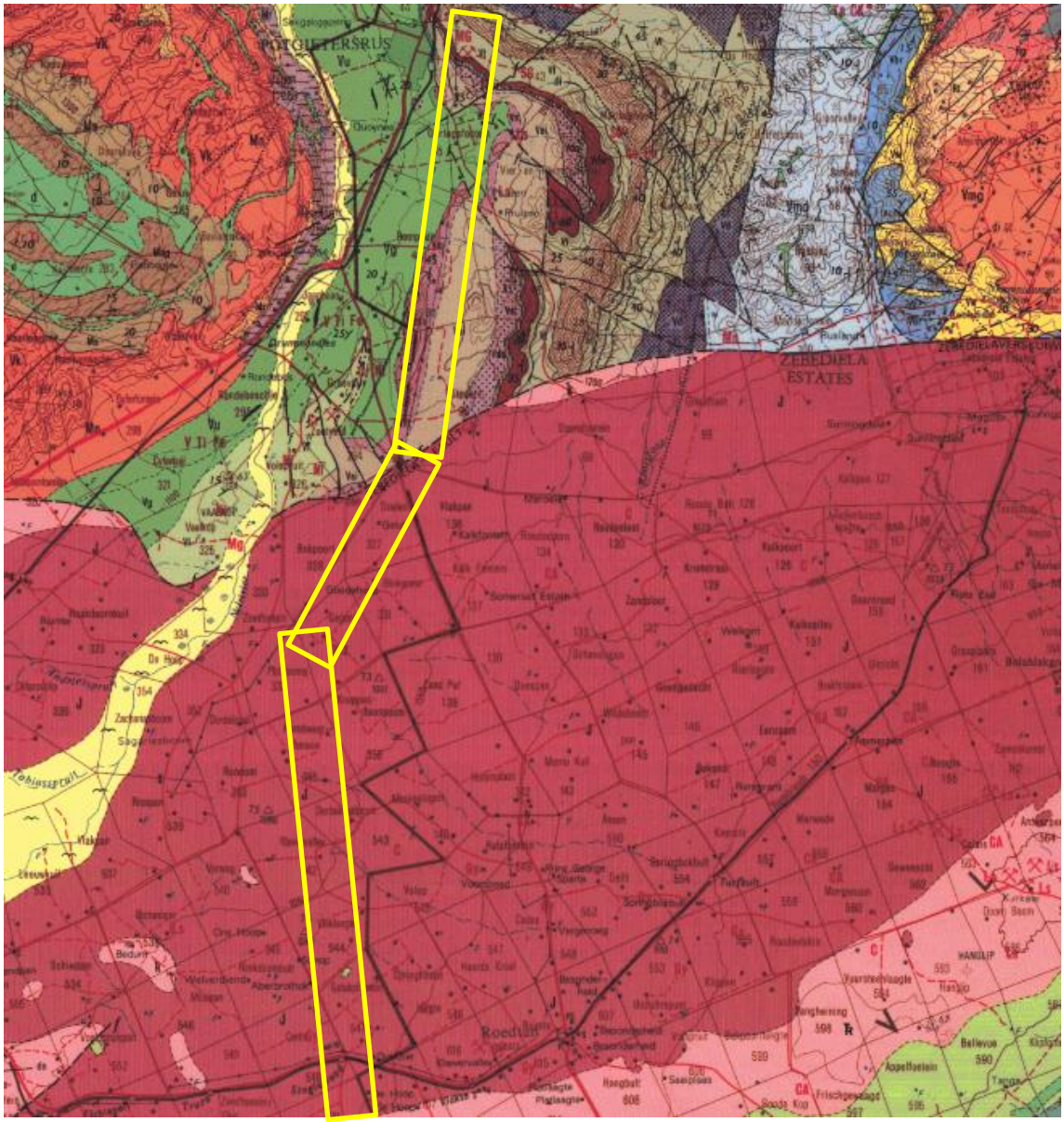

Figure 4: Geological map of the area around the northern-central route (Section 2) of the Boruthro-Silimela Powerline. The proposed route is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2428 Nylstroom.

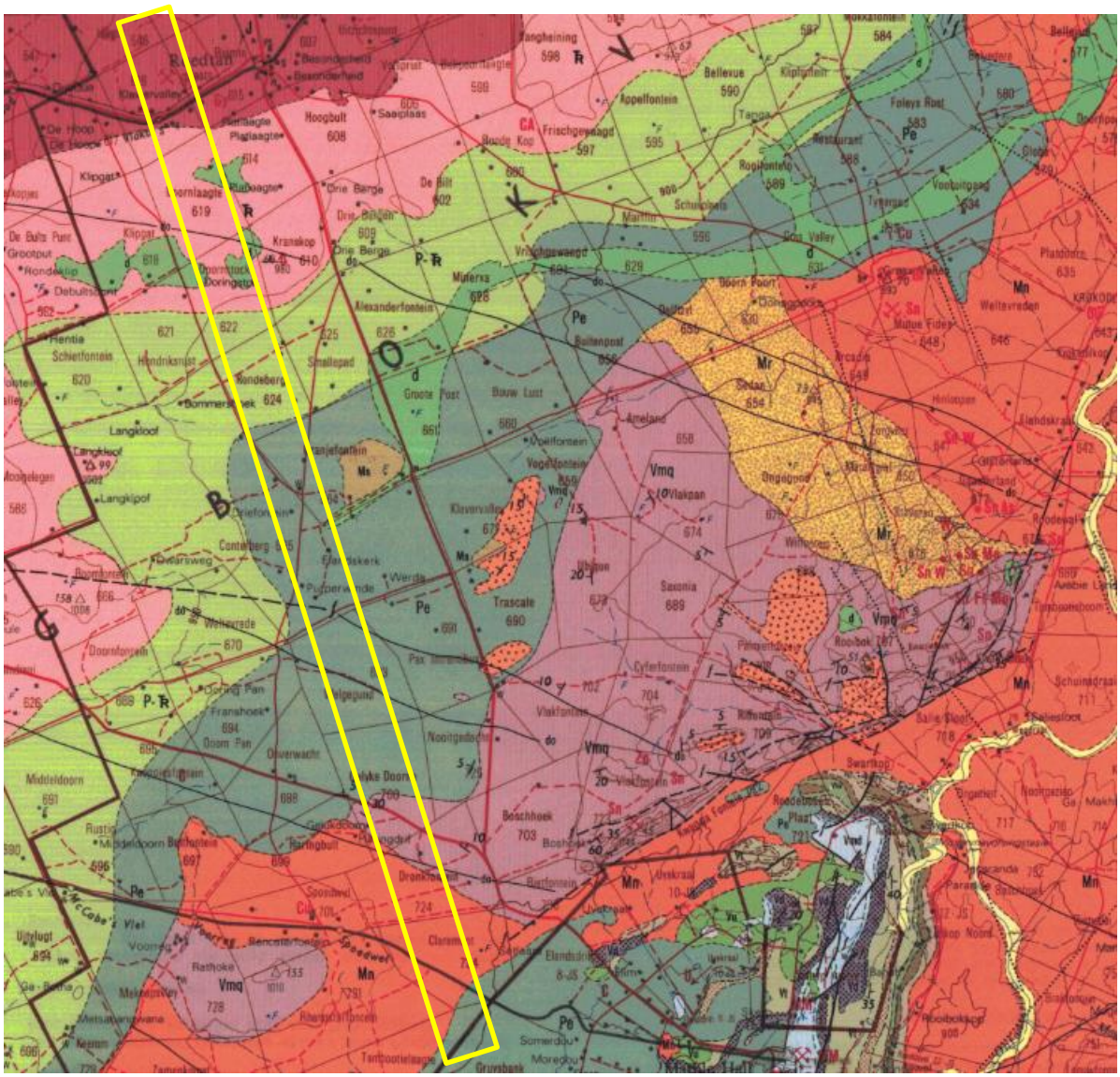

Figure 5: Geological map of the area around the central-southern route (Section 3) of the Boruthro-Silimela Powerline. The proposed route is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2328 Polokwane (top) and 2428 Nylstroom (bottom)

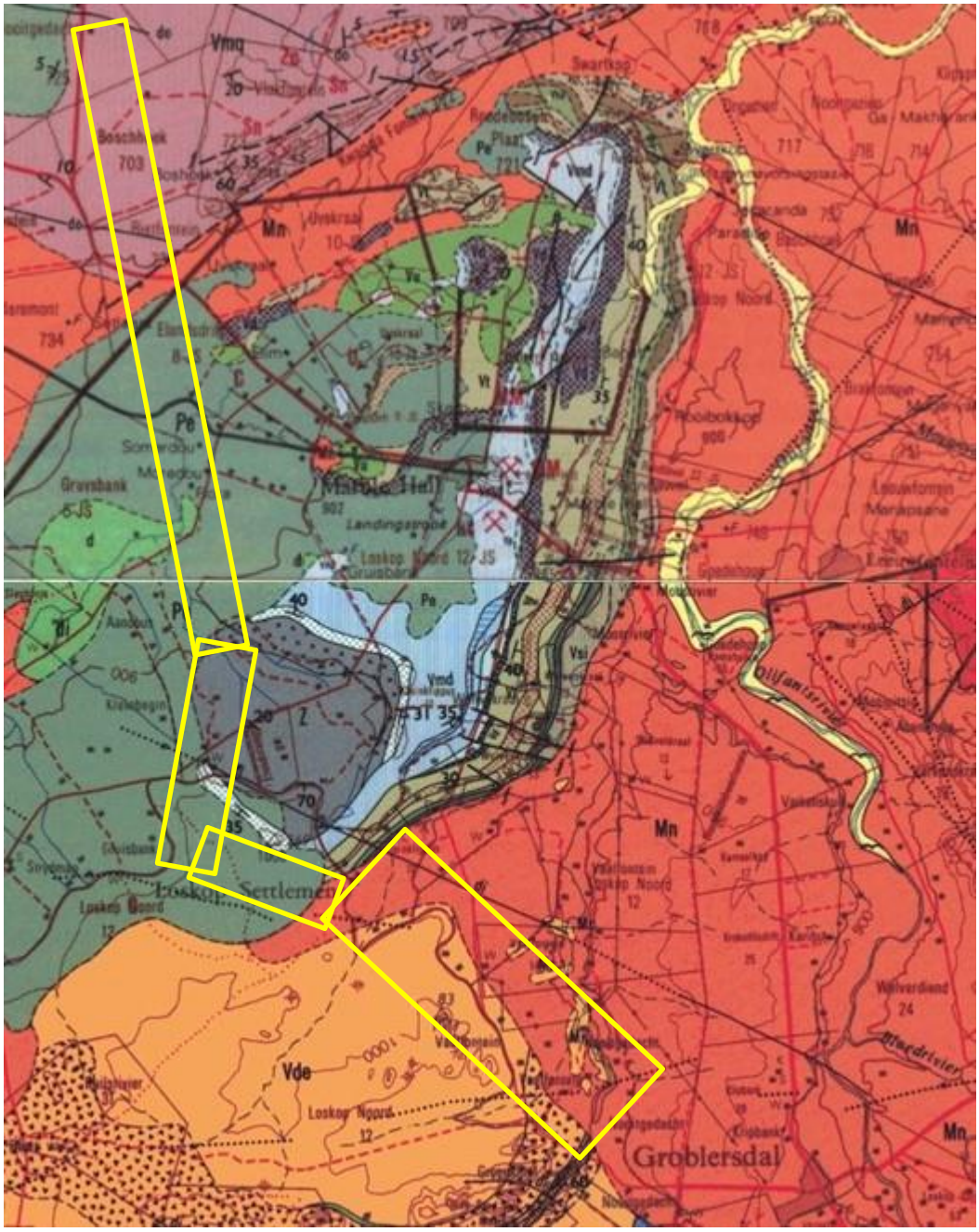

Figure 6: Geological map of the area around the southern route (Section 4) of the Boruthro-Silimela Powerline. The proposed route is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 2428 Nylstroom.

ii. Palaeontological context

The palaeontological sensitivity of the sections of the route under consideration are presented in Figures 7 (whole route), 8 for the northern highly sensitive section and 9 for the southern highly sensitive section.

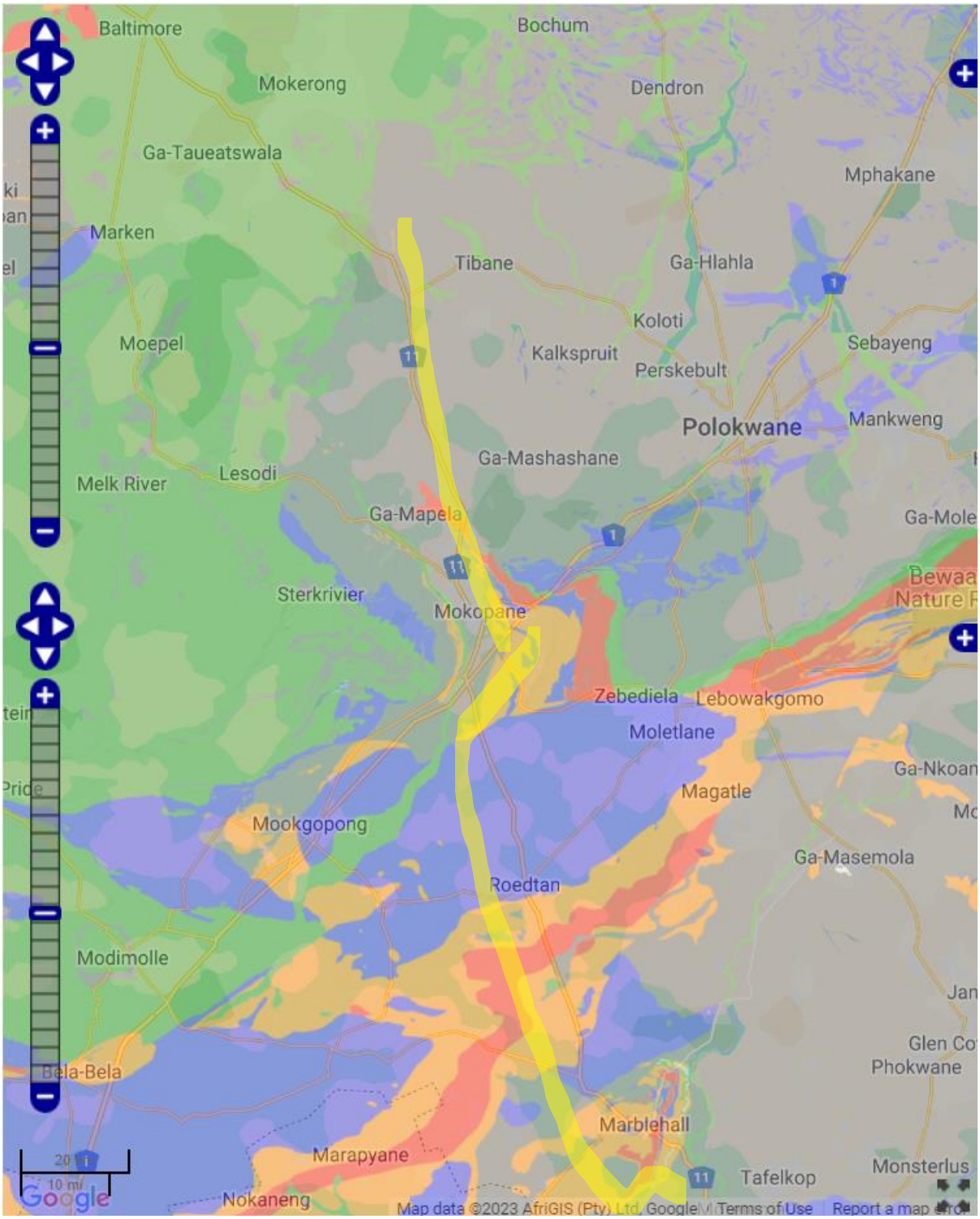

Figure 7: SAHRIS palaeosensitivity map for the site for the whole route for proposed Boruthro – Silimela 400kV powerline shown within the yellow band. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero. The northern section on red and the southern section on red are enlarged in Figures 8 and 9 below, respectively.

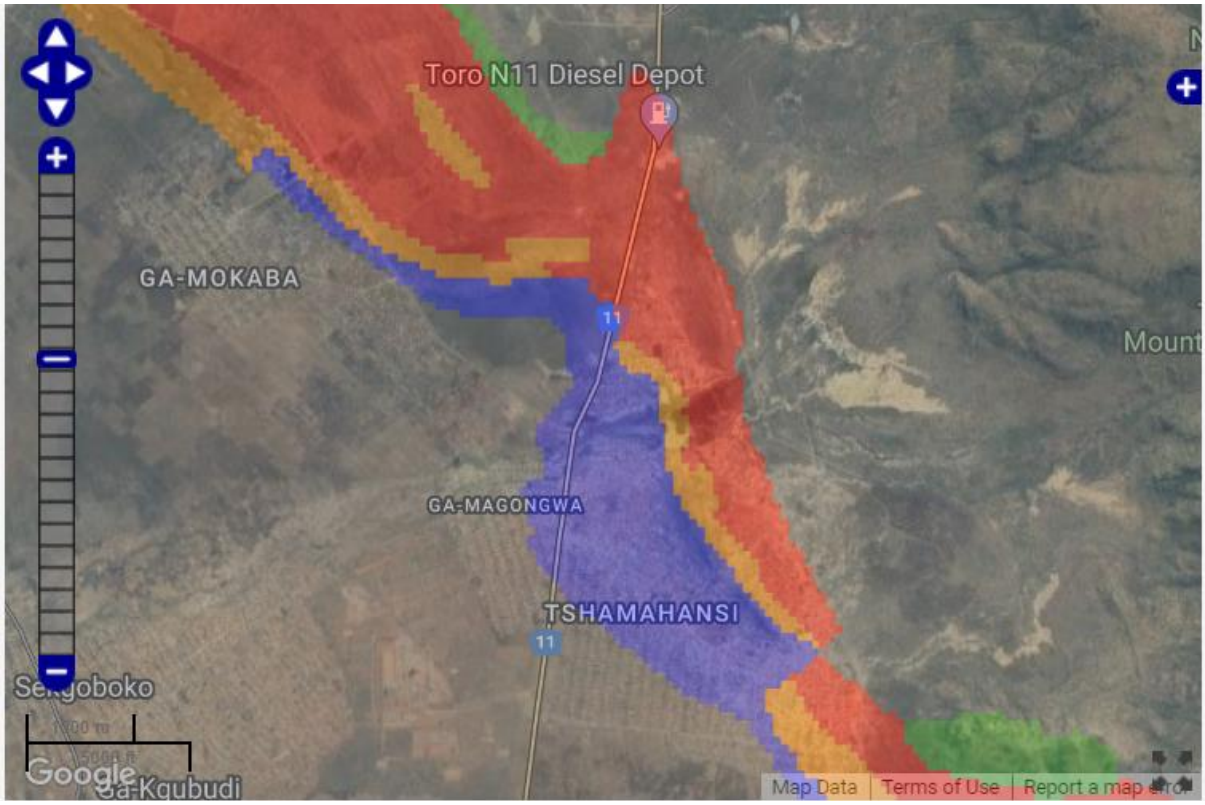

Figure 8: SAHRIS palaeosensitivity map for the northern red section. Colour coding as for Figure 7. Red is for the Malmani Group dolomites(Vmd) .

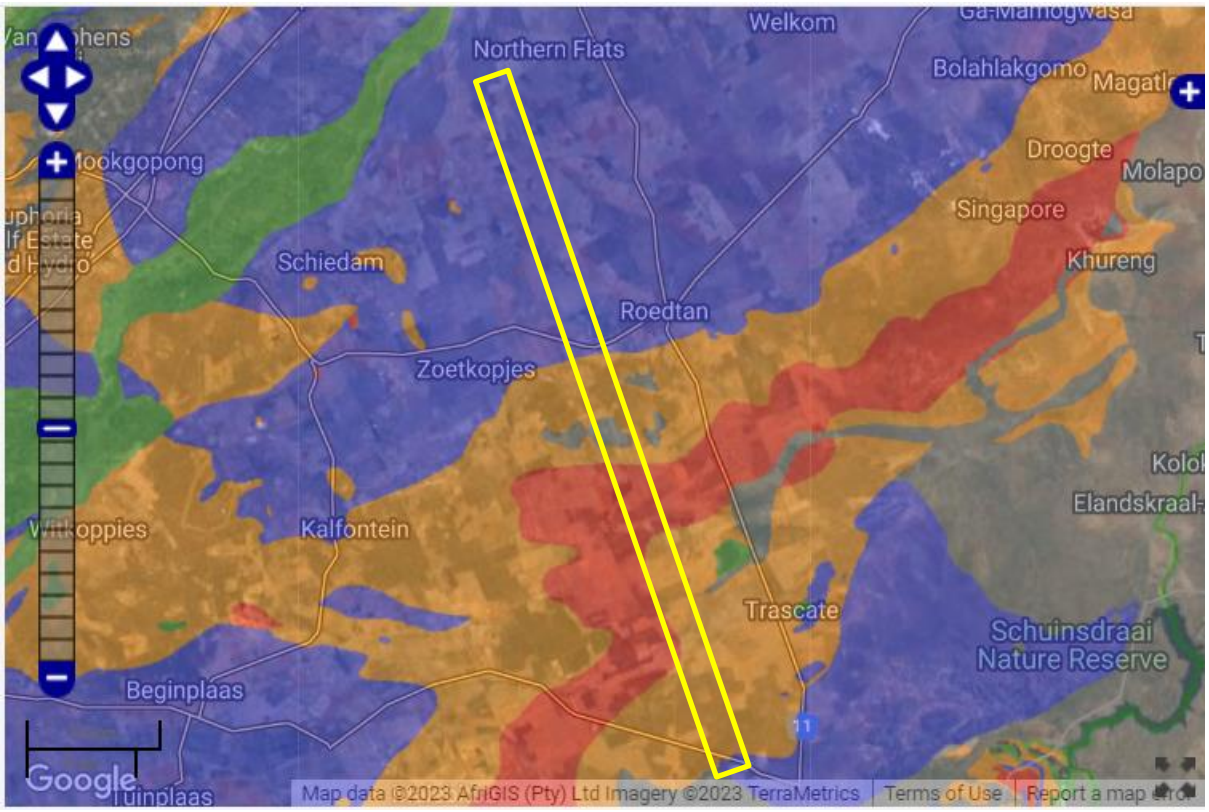

Figure 9: SAHRIS palaeosensitivity map for the southern red section. Colour coding as for Figure 7. Red is for the Irrigassie Formation (P-Tr).

Most of the route, especially in the northern section 1, is along non-fossiliferous granites and the Bushveld Igneous Complex (Figures 3, 7). Volcanic rocks do not preserve fossils and nor metamorphosed volcanic rocks (Cowan, 1995).

In section 1, the route is along some potentially fossiliferous rocks of the Transvaal Supergroup, such as the Timeball Hill and Silverton Formations, however, there are no confirmed records for these two strata. In contrast, the Malmani Subgroup (basal Transvaal Supergroup) does preserve trace fossils such as stromatolites. The short sections in Section 1 (Geology map Figure 3; palaeosensitivity maps Figures 7-8) might have dolomites and stromatolites.

Stromatolites, trace fossils of algal colonies, could occur in the Malmani Subgroup. They would appear as finely laminated domes in the dolomite.

In the southern route, between Roedtan and Marble Hall (Figure 2; P-Tr in the geology map Figure 5; palaeosensitivity maps Figures 7 and 9), a short section is on potentially fossiliferous rocks of the Irrigassie Formation (Karoo Supergroup). The Irrigassie Formation (equivalent of the Vryheid Formation) has extensive coal seams of Early Permian age. Although coal is formed from buried peat that is altered over time by high temperatures and pressures, the original plants that made the peat are not recognisable. The carbonaceous shale bands and lenses between the coal seams are more likely to preserve impressions of the plants. They are typical plants of the *Glossopteris* flora that includes leaves, seeds, reproductive structures and wood of *Glossopteris*, as well as other plants such as lycopods, sphenophytes, ferns and early gymnosperms.

4. Impact assessment

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

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	Soils do not preserve fossils; so far there are records only from the Malmani Subgroup and Irrigassie Fm of trace and plant fossils, respectively, in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	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 trace fossils in the Malmani Subgroup dolomites and plant fossils in the shales of the Irrigassie Fm, 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 soils and sands that cover the area but a low chance that trace fossils occur in the Malmani Subgroup and fossil plants in the Irrigassie Fm. Nonetheless, 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 much too old to contain fossils, are the wrong kind, or in ethe case of the

Malmani Subgroup and Irrigassie Formation, might contain fossils stromatolites or plants, respectively. Since there is a small chance that fossils may occur in these two strata and may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is mostly extremely low, with two sections low to moderate.

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 only some do contain trace fossils or fossil plant material. The overlying sands and soils of the Quaternary period would not preserve fossils. It should be noted that most of the route is along disturbed ground, on road servitudes or adjacent to the existing powerlines.

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 overlying soils and sands of the Quaternary. There is a small chance that fossils may occur in the Malmani Subgroup dolomites (Farm Rietfontein 2) and the southern section Irrigassie Formation (Farms Doringstock 623 and Rondeberg 624). There is a very small chance that fossils might occur in the route sections indicated as orange on the SAHRIS palaeosensitivity map (Figure 7). Therefore, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the contractor, environmental officer, or other responsible person once excavations for pole foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be very low for most of the route but low for two sections (Table 5).

Table 5: Summary of palaeontology for the sections of the Boruthro – Silimela 400kV powerline route. FCFP = Fossil chance find protocol (see section 8 and appendix A). **FCFP** = low to moderate sensitivity; FCFP = low sensitivity.

Pal section	Route, north to south	Geology	Palaeontology	Action required
1	Boruthro SS to Mokopane	Rhr, Rt Vmd Vg Vt	No fossils Stromatolites No fossils Possible fossils	None **FCFP** None FCFP
2	Mokopane to Roedtan	Vt Vg Jd	Possible fossils No fossils No fossils	FCFP None None
3	Roedtan to Marble Hall	Tr P-Tr	No fossils Fossil plants	None **FCFP**

		Vmq Mn Pe	No fossils No fossils Possible plants	None None FCFP
4	Marble Hall to Silimela SS	Vhq Mn Pe Mn Vde	No fossils No fossils Possible plants No fossils No fossils	None None FCFP None None

Based on the above sensitivity verification it can be confirmed that:

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	High to Zero	Very Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

7. References

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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 discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites, plants, insects, bone or 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 Figures 10-11). 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 then a 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.

9. Appendix A – Examples of fossils from the Malmani Subgroup and Irrigassie Formation

Figure 10: Photographs of stromatolites as seen in the field, from the Malmani Subgroup.

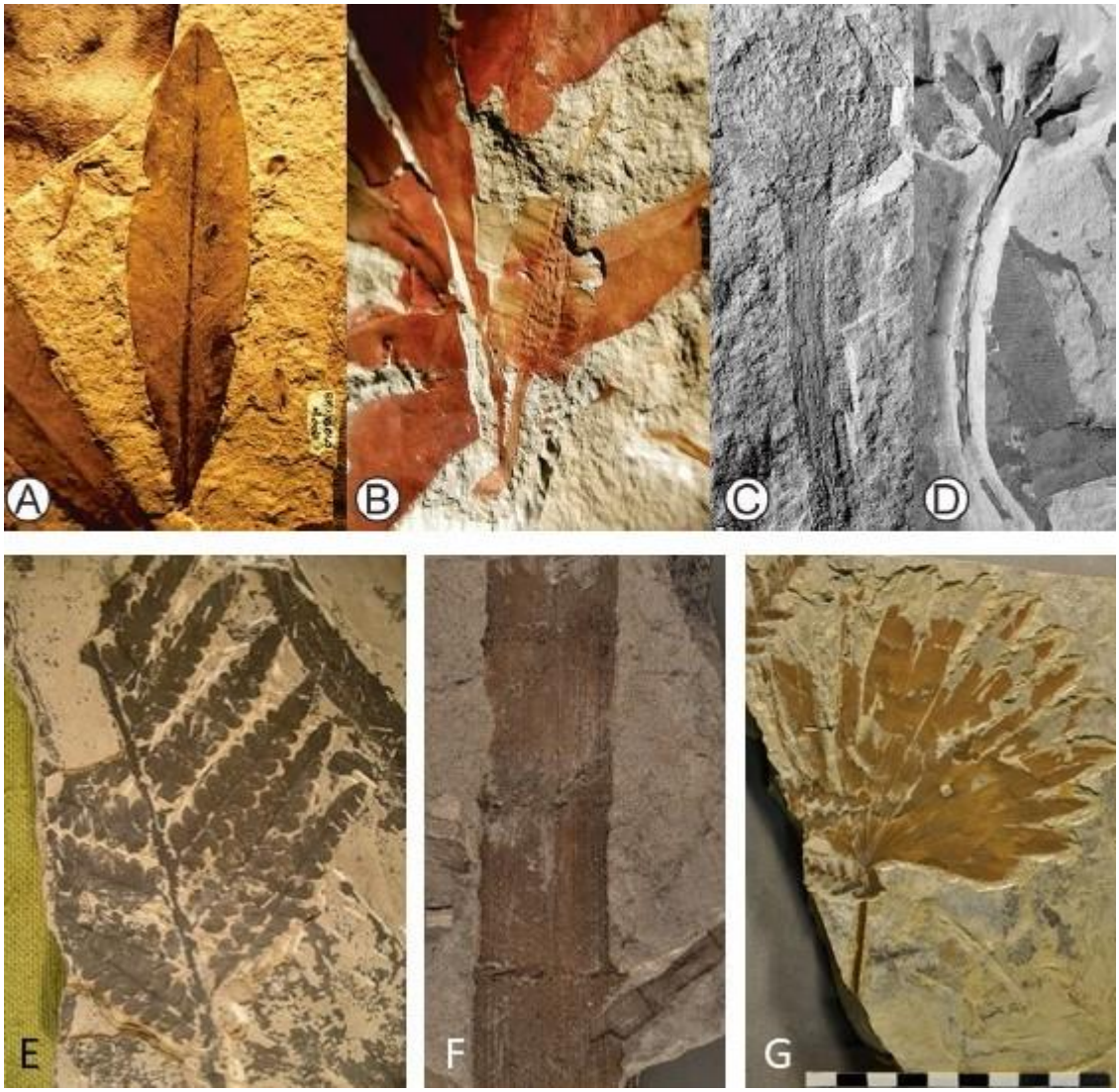

Figure 11: Photographs of fossil plants of the *Glossopteris* flora that could occur in the Irrigassie Formation.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2024

Present employment:		Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone	:	+27 11 717 6690
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

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **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 12 - 20 students per year.

vii) **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 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
25 years' experience in PIA site and desktop projects

- Selected from recent projects only – list not complete:
- 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
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondelei SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage

ix) **Research Output**
Publications by M K Bamford up to January 2024 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 32; Google Scholar h-index = 40; -i10-index = 116 based on 7068 citations.
Conferences: numerous presentations at local and international conferences.