PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED SMITHFIELD TO ROUXVILLE AND ROUXVILLE TO ZASTRON (BOPHELO) 33KV POWERLINE ROUTES, FREE STATE PROVINCE

PALAEONTOLOGICAL IMPACT ASSESSMENT SITE VISIT REPORT (PHASE 2)

REPORT SUBMITTED TO:

Eskom Distribution Division

Free State Operational Unit

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REVISION AND AMENDMENTS

DATE	No.	DESCRIPTION OF REVISION OR AMENDMENT
01/06/2023	1	Final Version revision

EXECUTIVE SUMMARY

A site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed construction of a 33 kV powerline from Smithfield to Rouxville and from Rouxville to Zastron (Bophelo) in the southeastern Free State. In order 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), the desktop PIA recommended a site visit. This was done from 08-13 July 2021 and the results are reported herein.

The Smithfield – Rouxville route lies on potentially fossiliferous rocks of the Tarkastad Subgroup (including the Katberg and Driekoppen Formations; upper Beaufort Group, Karoo Supergroup), and on Quaternary alluvium. The Rouxville – Bophelo route lies rocks of the Tarkastad Subgroup, and also on potentially fossiliferous rocks of the Molteno Formation (Stormberg Group, Karoo Supergroup). Fossils that might be found are vertebrate fossils of the *Lystrosaurus* and *Cynognathus* Assemblage Zones in the Tarkastad Subgroup, and plants of the *Dicroidium* flora in the Molteno Formation. No fossils will be found in the Jurassic dolerite, and it is extremely unlikely that they would be found in the Quaternary allium and soils.

Site observations: No fossils were found along the powerline routes. There were no rocky outcrops along the routes and the land was covered in soils and vegetation so no underground rocks were visible. The abundant termitaria attest to the deep soils.

Recommendation: Fossils might be exhumed when the foundations for the poles are excavated. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found they should be put aside in a safe place and a professional palaeontologist should be called to assess the fossisl and collecte a representative sample to be donated to the Palaeontology department of th National Museum in Bloemfontein for curation and research.

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1. BACKGROUND

As part of the national plan to improve the supply of electricity to towns in South Africa, Eskom plans to construct a 33 kV overhead power line, using several styles of poles, between Rouxville and Smithfield, and Rouxville and Zastron (Bophelo) in the southeastern Free State (Figures 1-3). The distance between Rouxville and Smithfield is approximately 28 km and there will be 331 poles (RVSM1 – RVSM331). The distance between Rouxville and Zastron is a little less and there will be 214 poles (RVZT1 to RVZT214). The type of pole structure has no impact on the palaeontology, only the area and depth of excavations for the foundations are relevant. An area of 2 x 2m and depth of less than 3m appears to be the maximum from the drawings of structures provided.

A desktop Palaeontological Impact Assessment (PIA) was completed for the in order to comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). A site visit PIA (Phase 2) was recommended, completed and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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	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

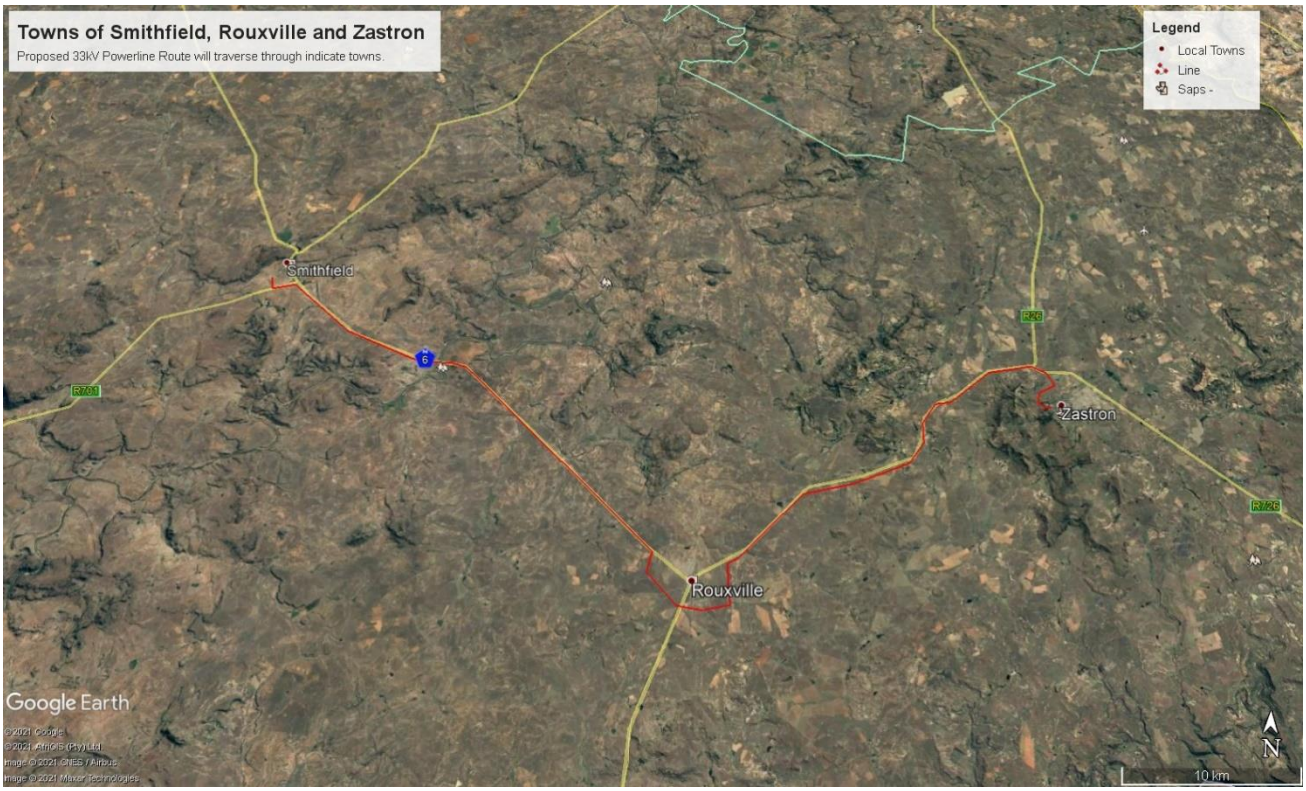

Figure 1: Google Earth map of the powerline route between Rouxville and Smithfield, mostly alongside the N6 road. Map supplied by Thero Services.

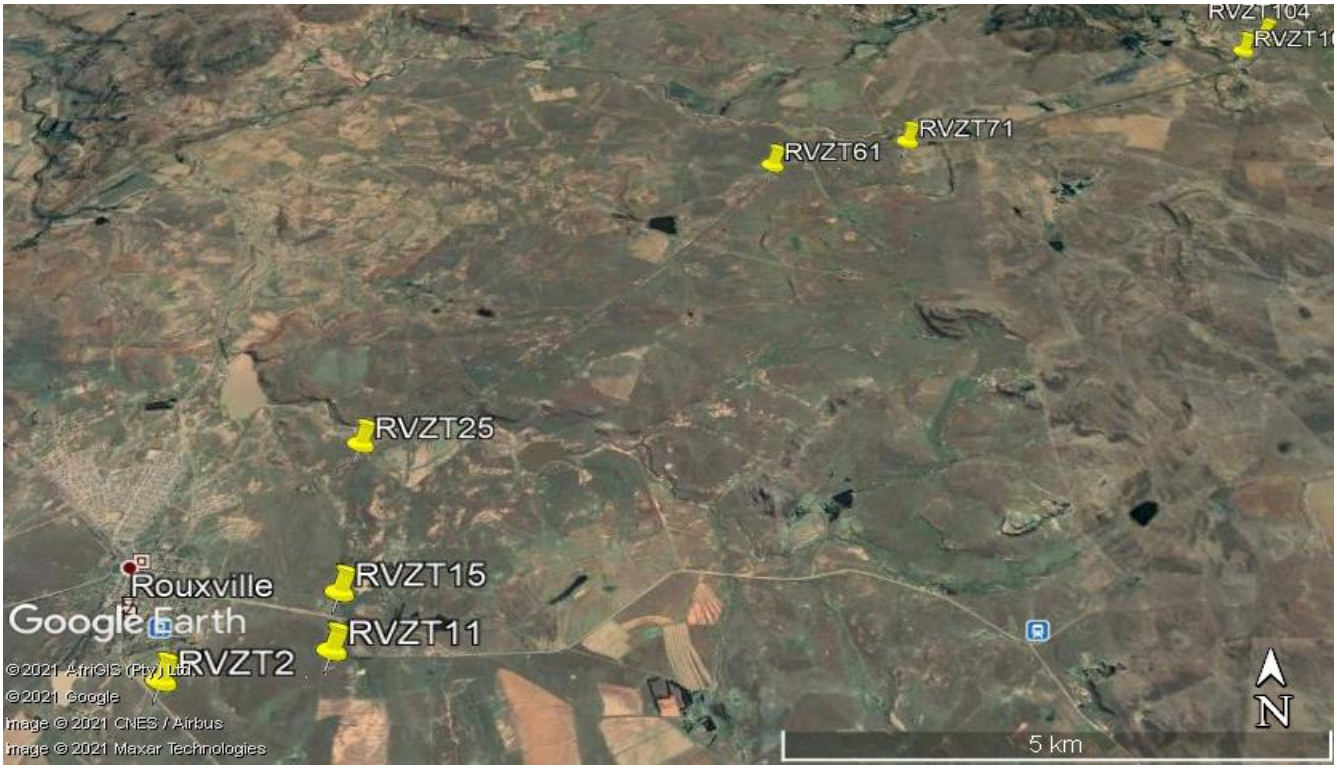

Figure 2A: Google earth map of the powerline route between Rouxville and Zastron (Bophelo), mostly along the R26 road. Points provided were too faint to see so key points where the line changes direction have been added as pins: RVZT1 to RVZT71

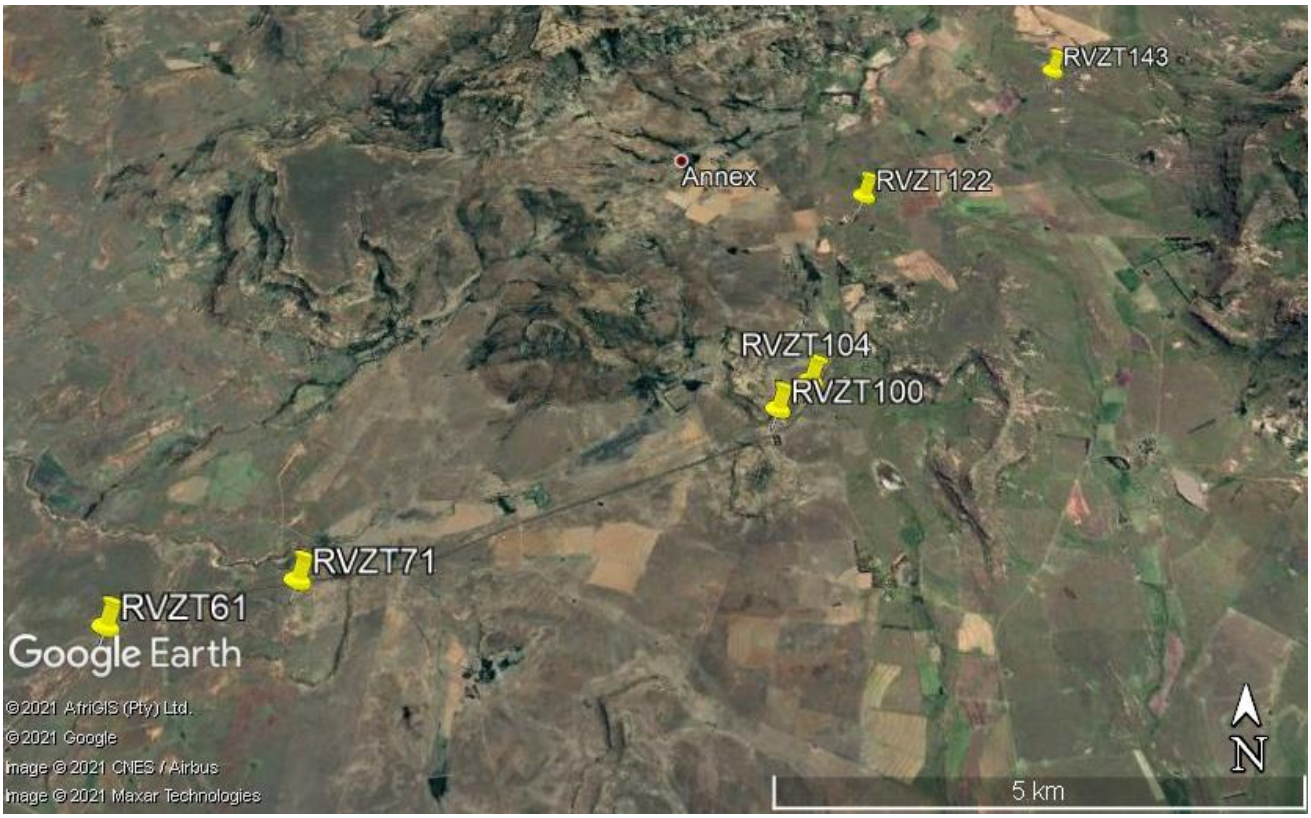

Figure 2B: Google Earth map pins RVZT61 to RVZT143.

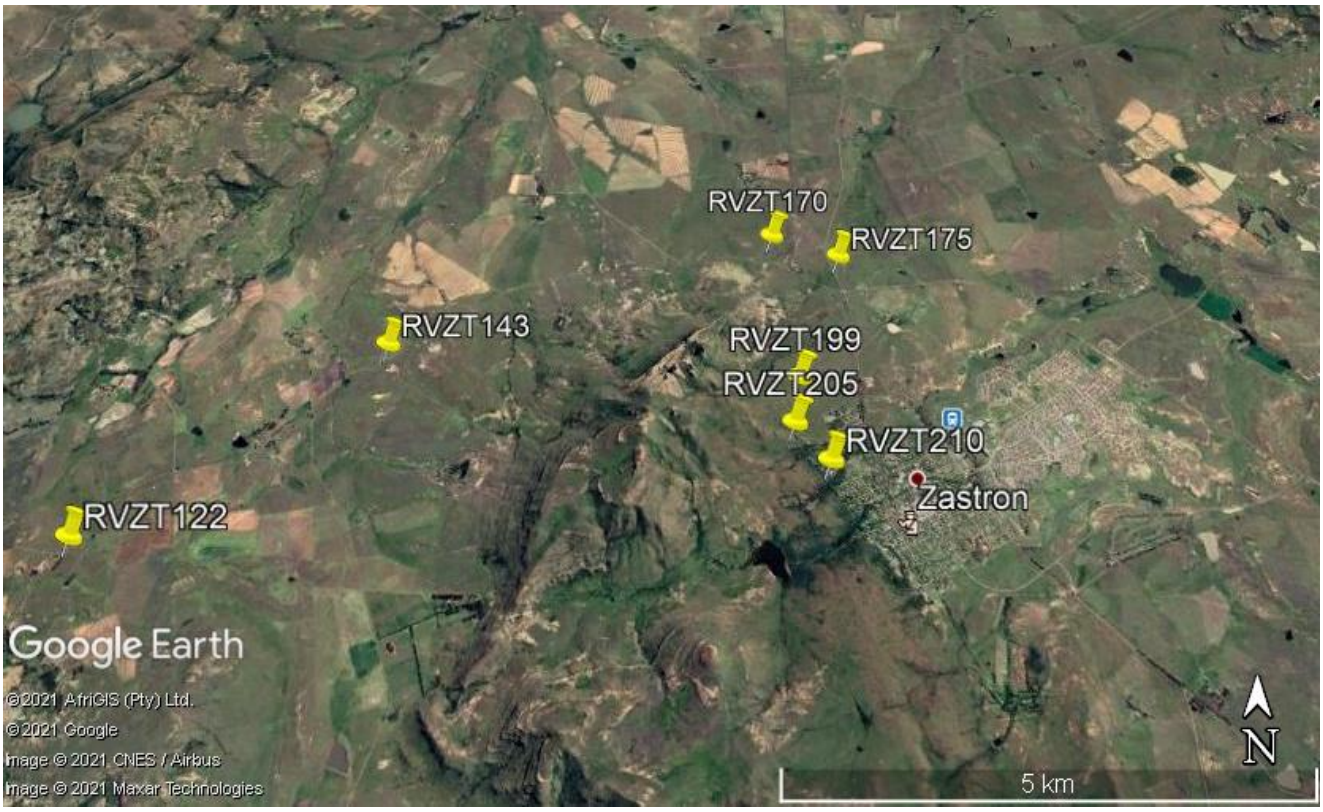

Figure 2C: Google Earth map pins RZVT122 – RZVT210

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:

- 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;
- Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
- 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
- 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

3.1 Project location and geological context

Figure 3: Geological map of the area between Smithfield (northwest) and Rouxville (southeast) with the N6 road between the towns, along which the power lie will run. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3026 Aliwal North.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Botha and Smith; 2020; Hancox et al., 2020, Rubidge et al., 1995). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, soil	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Tre	Elliot Fm, Stormberg Group, Karoo SG	Brownish-red and grey mudstone, sandstone	Upper Triassic to Early Jurassic
Trm	Molteno Fm, Stormberg Group, Karoo SG	Gritty sandstone, grey mudstone, shale, coal	Middle Triassic
Trt	Tarkastad subgroup, Beuaufort Group, Karoo SG	Brown-red and grey mudstone, sandstone	Early Triassic

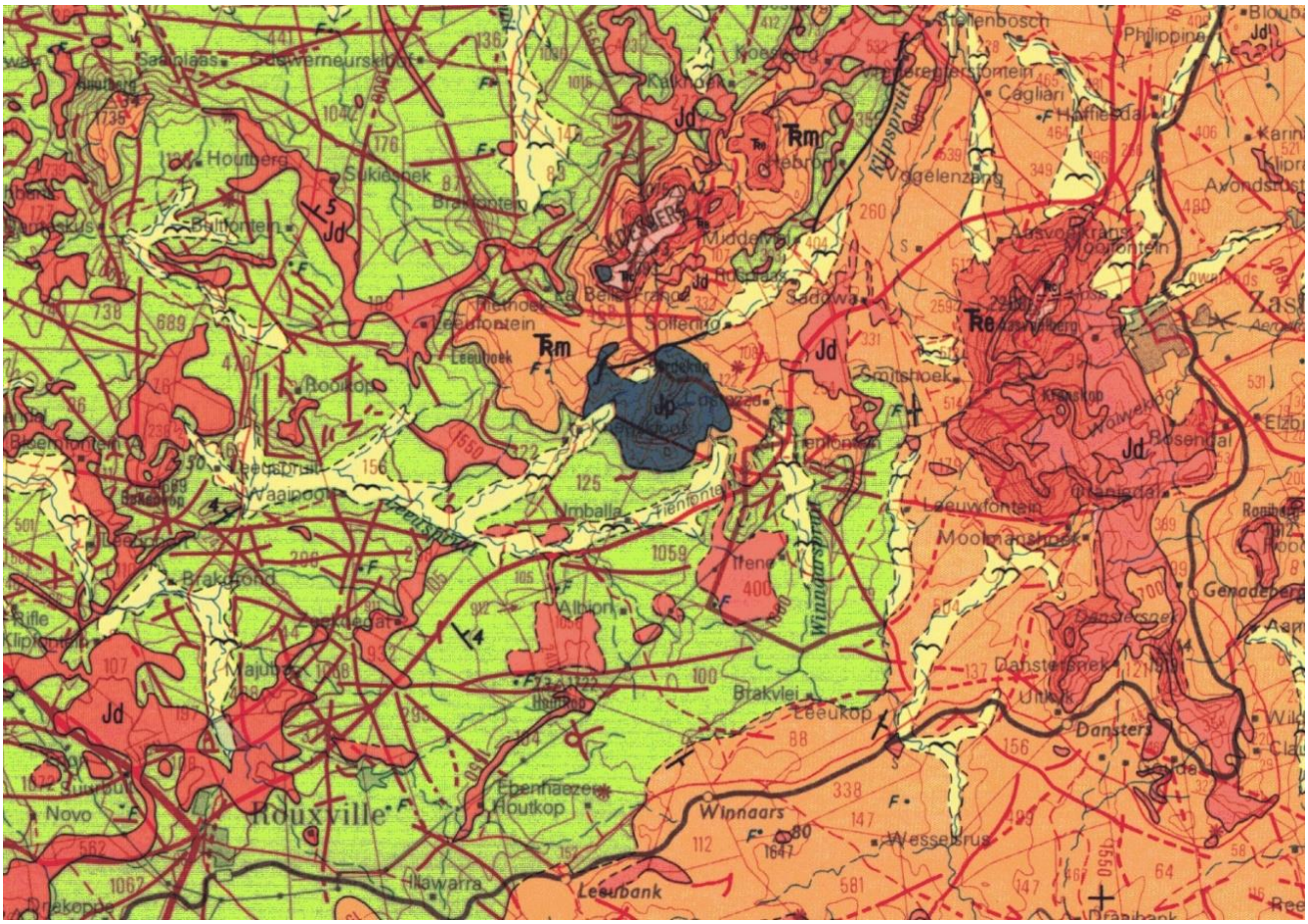

Figure 4: Geological map of the area between Rouxville (southeast) and Zastron (northeast) with the R26 road between the towns, along which the power lie will run. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3026 Aliwal North.

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest (Nieuwoudville – Inverdoorn) and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous period South Africa was part of the huge continental landmass known as Gondwanaland and it positioned over the South Pole. Meltwater sediments are known as the Dwyka Group.Overlying them are rocks of the Ecca Group that are Early Permian in age.

Overlying the Ecca Group rocks are the Beaufort Group Rocks that are late Permian and early Triassic in age. There are six formations in the Beaufort Group but their distribution is not the same throughout the basin. The Adelaide Subgroup makes up the middle to upper Permian rocks and the Tarkastad Subgroup makes up the early and middle Triassic rocks

The Tarkastad Subgroup was deposited in the early Triassic. Two lower formations are recognised, the Katberg Formation west of the line of longitude 24°E and the Verkykerskop Formation in the Free State and KwaZulu Natal, with the former representing shallow, braided environment with pulsatory discharges. It also has abandoned channel fills and braidplain environments, and the latter just representing a braidplain environment (Catuneanu et al., 1998).

The upper part of the Tarkastad subgroup has the Burgersdorp Formation in the east and the Driekoppen Formation in the west. Both formations were deposited as mixed-load meandering rivers and floodplains with more suspended-load-dominated meandering river deposits in the Driekoppen Formation (ibid).

The Stormberg Group forms the upper Karoo sequence and has been divided into thre formations, the lower Molteno Formation, the Elliot formation and the upper Clarens Formation. These rocks were capped by the Drakensburg basalts that signalled the end of the Karoo sequence, as well as preserving much of the stratigraphy.

The Molteno Formation, of upper Triassic age, represents braided streams on a vast braid plain, rare coal deposits with a few filled in abandoned channel tracts and some ponded bodies of water (Catuneanu et al., 1998). It was a part of the ever-shrinking Karoo Basin and only occurs around the margins of the Drakensberg Mountains.

3.2 Palaeontological context

Fossil plants are very rare in the Katberg and Verkykerskop Formations. In contrast there is a richer vertebrate record and the fauna is known as the Lystrosaurus Assemblage Zone (AZ) (Rubidge et al., 1995). Recently this has been refined and is now called the Lystrosaurus declivis AZ (Botha and Smith, 2020). Common vertebrates are amphibians, reptiles, parareptiles, anomodonts, therocephalians and cynodonts.

Early examples of the *Dicroidium* flora are known from the middle Triassic Burgersdorp Formation and include seed ferns and early gymnosperms, some bennetittaleans and ferns (See Appendix A). The Cynognathus AZ is found in the upper Tarkastad Subgroup and typical vertebrates are amphibians, reptiles, parareptiles, anomodonts, therocephalians and cynodonts. These are the same groups as occur in the older Lystrosaurus AZ but the genera and species are different (see Appendix B). Hancox et al. (2020) have subdivided the Cynognathus AZ into three subzones but only experienced vertebrate palaeontologist would be able to recognise the taxa.

Molteno sediments preserve an extremely rich and diverse flora in many small outcrops. They have been extensively collected and studied by Heidi and John Anderson (Anderson and Anderson, 1985; Anderson et al., 2020). No vertebrates occur, except a few footprints. The plants are known as the *Dicroidium* flora and comprise the seed fern *Dicroidium*, many ferns, sphenophytes, ginkgophytes and extinct gymnosperms (see Appendix A, B).

3.3 Site Visit Observations

A site visit was completed from 09 July to 12 July 2021 by Prof Bamford and Dr House, with the assistance of Mr Paul Jansen (Eskom, Zastron Office) on 09 July. Both routes were traversed on the first day and on the subsequent three days sections were revisited in order to complete the route and fill in the gaps and to take more photographs. The stops, therefore, are not sequential (see Appendix B) but the information has been compiled for ease of reference in Table 3 for the routes in the directions of the pole numbering by Eskom, namely Rouxville to Smithfield, and Rouxville to Zastron (Bophelo). A selection of photographs has been assembled in plates (Figures 5-14) of only some of the features seen.

Table 3: Site observations, farms, poles, geological strata and relevant figures.

Rouville to Smithfield 33kV powerline – approx. 35km					
Farm Name	Pole No RVSM	sG/Fm	Stop	Observations	Fig
Rouxville Townlands 108	1-10	Tarkastad sG	37	Natural grazing; grassland, medium deep soils; no rocky outcrops; no fossils	5
Rouxville Townlands 108	11-14; 15-37	Tarkastad sG	37	dam, natural grazing, past agriculture; grassland; no rocky outcrops along route	
Enon 1072	38-68	Tarkastad sG		Natural grazing; 40 chg dtn; 54-55 cr road to NE side; around 66-67 quarry for dolomite; grassland,	
Schatfontein 942	69-79	Tarkastad sG	7, 27	Natural grazing; grassland; no rocky outcrops; no fossils	6
Kleinspruit 513	80-98	Tarkastad sG	6, 25	Natural grazing; grassland; no rocky outcrops; no fossils	
Kleinspruit 742	99-114	Tarkastad sG	5	Cultivated grazing; grassland only	
Vischgat		Tarkastad sG			
Drenthe 254	115-131	Tarkastad sG	24	Natural grazing; grassland; no rocky outcrops; no fossils	7
Eldorado 1085	132-149	Tarkastad sG	4	Cultivated grazing; no rocky outcrops along route; no fossils	
Groot Vley 1084	150-154	Tarkastad sG	3	Agriculture; grasslands, few trees; no fossils	
Klipplaatdrift 68	155-177	Tarkastad sG	23	Agriculture; grasslands, few trees; no fossils	
Waterford B 1098	178-208	Quaternary	1	Caledon River; Natural grazing; 191 - 196 chg N around donga; 200 goes W; 206-206 AB	8
Bitter Swaar Bekom 782	209-232	Tarkastad sG	1	Natural and cultivated grazing; Commissiedrif 303; 220-221 over dirt rd	
Slangfontein 526	233-255	Tarkastad sG	22	Irrigated land; deep soils; no rocky outcrops; no fossils	
Bonnie Vale 75	256-289	Tarkastad sG	21	Irrigated land; 248 west over road to 259	
Groenspruit 516	290-301	Tarkastad sG	20	Irrigated land; deep soils; no rocky outcrops; no fossils	9
Smithfield Townlands	302-331	Quaternary	19	ends at Substation; grasslands, disturbed. Trees; old buildings; no fossils	
Rouxville to Zastron (Bophelo) 33kV power line – approx 28km					
Farm Name	Pole No RVZT	sG/Fm	Stops	Comments	Fig
Dorpsgronden of Rouxville 108	1-11	Tarkastad sG	12	road crossing; dam; grassland grazing	11
Middelplaats 116		Tarkastad sG	12	grassland, grazing	11
Paisley B 1039	15	Tarkastad sG	11	grassland, grazing	
Paisley B 1039	25	Tarkastad sG	12	R26 road crossing, grassland, grazing, previous agriculture	
Paisley Dam 1099		Tarkastad sG		grassland, grazing	
Ingogo 372		Tarkastad sG		grassland, grazing	
Port Elizabeth 295		Tarkastad sG		grassland, grazing	
Locomotief 297	61-71	Tarkastad sG		grassland, grazing	
Zeekoegat 105		Tarkastad sG		grassland, grazing	
Fraaiuitzicht 322		Tarkastad sG		grassland, grazing	

Knegtskloof 125		Tarkastad sG		grassland, grazing	
Umbala 1059	100	Tarkastad sG	13	koppie with bushes; route in grassland and no fossils	12
Henning'sdale 400		Tarkastad sG		grassland, grazing	
Tienfontein 82	104	Tarkastad sG		grassland, grazing; gullys but no rocky outcrops	
Umbala 1059		Tarkastad sG		grassland, grazing	
Custozza 122		Tarkastad sG		grassland, grazing	
Custozza 122		Tarkastad sG		grassland, grazing	
Zevenfontein 254	122	Molteno Fm	34	quarry with water; rocky outcrop alongside road but no fossils	13
Saddwa 331		Molteno Fm	14	grassland, grazing; route around farm; no rocky outcrops; no fossils	
Haarlem 259		Molteno Fm	15	grassland, grazing; route crosses over road; no fossils	
Balfast 513	143	Molteno Fm		grassland, grazing	
Aasvoelkrans 539		Molteno Fm		grassland, grazing; route on flat land avoiding the kranz with Elliot Fm capping	
Vogelgenzang 349	170	Molteno Fm	16	grassland, grazing; no rocky outcrops	
Vogelenzang 349		Molteno Fm	35	disturbed grassland, trees, no fossils	
Mooifontein 480	175	Molteno Fm	17	substation; grassland, previous agriculture	14
Mooifontein 480	212	Molteno Fm	17	substation; grassland, previous agriculture	

Figure 5: Rouxville (to Smithfield) Stop 11; a – existing Rouxville substation with powerline leadind in; b – powerline leading northwards towards Zastron; grassland vegetation along powerline route close to the substation; c – grassland vegetation along powerline route; d – grassland along route farther along.

Figure 6: Rouxville to Smithfield (Stop 7), Farm Enon; a - powerline route just beyond the fence in the grassland; b – termite mound in the grassland indicating that there are deep well-drained soils below the grond surface; c – close-up of thick tufted grasses; d – powerline route in grasslands farther along on Farm Schatfontein.

Figure 7: Rouxville to Smithfield (Stop 24); a; Farm Drenthe with Vodacom tower coming between the dolerite ridges where the new powerline will be; b, c - closeup of the substrate showing soils and vegetation; d – dolerite ridge with bushes (*Searsia erosa* and *Searsia* sp.) behind the powerline route.

Figure 8: Rouxville to Smithfield (stops 22 and 23); a – Caledon River with Quaternary alluvium along the bank and in the valley; b – north of the Caledon River with the exisiting powerline route that is adjacent to the new route; c – rare exposure of bare soil and some shale but no fossils; d – grassland along the route with another dolerite ridge in the background on Waterford farm.

Figure 9: Rouxville to Smithfield – Smithfield substation; Groenspruit (Stop 19); a – eroded soil along route showing depper soils; closeup of short, grazed grasses and no rocky outcrops; c, d – grassland along route.

Figure 10: Road cutting on the N6 (Stop 18) just to provide and indication of the type of rocks being looked for as they are mudstones of the Tarkastad Subgroup but did not have any fossils; a, b – massive mudstones with thin cappings of sandstone overbank deposits; c, d – finely laminated mudstones fracture and weather rapidly whn exposed to the air.

Figure 11: **Rouxville to Zastron section** starting north of Rouxville (see Fig. 5 for substation) where the new powerline crosses from the east side to the west side of the R26 road; Middelfontein; a – powerline comes from centre background to centre foreground in grassland; b – closeup of the sols and grasses showing no rocky outcrops; c – beginning of west side route in grassland with deep soils and termite mounds; d – route goes down the centre of the photo towards Zastron.

Figure 12: Rouxville to Zastron (Stop 13), Umbala; a – route looking south; b, c – closeup of thick grassland; d – route looking northwards.

Figure 13: Rouxville to Zastron (Stops 14, 15, 34) on Zevenfontein where the Molteno Formation replaces the older stratum; a – west side of road where the powerline will go; b – opposite side of the road where Molteno Formation shales are visible (a roadcutting confimed the strtum but had no fossils); c - Farm Sadowa around which the powerline will go to avoid the homestad and dam, all along grasslands; d – next farm here the grasses are particularly thick.

Figure 14: Rouxville to Zastron at the Zastron substation (Stop 17) Farm Mooifontein; a – line crosses over the R26 tice to approach the town – all grasslands; b – Aasvoelskrans with Elliot foration snadstones on the top; powerline passes in front of the krans on the flatter grassland route; c, d – location of the new Zastron substation in the foreground on flat, previously cultivated soils.

4. IMPACT ASSESSMENT

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

TABLE 4A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of	**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.

PART A: DEFINITION AND CRITERIA		
environmental impacts	**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	Vertebrate fossils are scattered in the Tarkastad sG and fossil plants occur in lenses in the Molteno Fm. So far there are no records from the area but it is possibley that fossils occur on the sites The impact would be moderate.
	L	-
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	-
	M	Since the possible fossils within the area would be vertebrates from the Lystrosaurus AZ and Cynognathus AZ, and fossil plants from the Dicroidium flora in the shales, the spatial scale will be localised within the site boundary
	H	-

PART B: Assessment		
PROBABILITY	H	-
	M	It is possible that fossils could occur along the route but it is not possible to predict their location. A site visit is recommended.
	L	

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 the correct age and type to contain fossils. Soils and alluvium do not preserve fossils. The site visit confirmed that there are no fossils and no potential rocky outcrops along the proposed routes for both sections. Since there is a moderate chance that fossils might be damaged when excavations commence for the pole foundations, a Fossil Chance Find Protocol is required.

5. ASSUMPTIONS AND UNCERTAINTIES

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. It is not possible to predict precisely where fossils might occur as their distribution is very sporadic. No fossils were seen during the site visit along the routes of both powerline sections.

6. RECOMMENDATION

Based on experience and the lack of any previously recorded fossils from the area, it is moderately likely that fossils would be preserved in the shales and sandstones of the Tarkastad Subgroup and Molteno Formation. Since it is not possible to predict their exact location, a site visit by a professional palaeontologist was completed. No fossils or potentially fossiliferous rocky outcrops were seen long the powerline routes. Since it is not known what lies below the soils, a Fossil Chance Find Protocol should be added to the final EMPr. If fossils are found when excavating for foundations begins, location must be noted with GPS co-ordinates and photographed in situ. If feasible and the integrity of the fossil is at stake, then a SAHRA permit must be obtained and the fossil(s) removed with due caution and care. Fossils must be housed in a suitable repository, the National Museum in Bloemfontein being the closest.

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.
- Anderson, H.M., Barbacka, M., Bamford, M.K., Holmes, W.B.K., Anderson, J.M., 2020. Dicroidium (foliage) and affiliated wood Part 3 of a reassessment of Gondwana Triassic plant genera and a reclassification of some previously attributed, Alcheringa: An Australasian Journal of Palaeontology 44, 64-92.
- Bamford, M.K. 2004. Diversity of the woody vegetation of Gondwanan southern Africa. Gondwana Research 7, 153-164.
- Botha, J., Smith, R.M.H., 2020. Biostratigraphy of the Lystrosaurus declivis Assemblage Zone (Beaufort Group, Karoo Supergroup). South African Journal of Geology 123, 207-216.
- Catuneanu, O., Hancox, P. J., & Rubidge, B. S. (1998). Reciprocal flexural behaviour and contrasting stratigraphies: A new basin development model for the Karoo retroarc foreland system, South Africa. Basin Research, 10, 417–439.
- Hancox, P.J., Neveling, J., Rubidge, B.S., 2020. . Biostratigraphy of the Cynognathus Assemblage Zone (Beaufort Group, Karoo Supergroup). South African Journal of Geology 123, 217-238.
- Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.
- Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.
- Rubidge, B.S. (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. Fossil 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 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 Figures 15, 16). 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/contractor 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

Lists of fossils from Tarkastad Subgroup and Molteno Formation.

Group/subG/ Formation	Plant group	Genera	Animal Group	Genera
Beaufort; Katberg Fm	Same as Driekoppen		Amphibia	*Lydekkerina, Thabanchuia, Eolydekkerina, Micropholus, Broomulus*
			Parareptila	*Saurodektes, Sauropareion, Procolphon, Colleta, Phonodus*
			Eureptilia	*Protocuchus, Prolacerta*
			Anomodontia	*Lystrosaurus, Myosaurus*
			Therocephalia	*Tetracynodon, Scaloposaurus, Olivierosuchus, Ericiolacerta, Regiosaurus*
			Cynodontia	Galesaurus, Progalesaurus, Thrinaxodon
Beaufort; Driekoppen Fm	Lycophyta	*Gregicaulis*	Pisces	*Phycoceratodus, Saurichthys, Lissodus* *Polyacrodus, Clethrolepidina*
Cynognathus AZ	Sphenophyta	*Calamites*	Amphibians	*Kestrosaurus, Trematosuchus, Parotosuchus, Bathignathus, +7*
	Filicophyta	*Asterotheca* *Cladophlebis*	Parareptilia	*Palacrodon, Theledectes, Thelerpeton, Thelephon, Myocephalus*
	Incertae sedis	*Bergesia*	Eureptilia	*Garjania, Erythrosuchus, Eohyosaurus, Howesia, Mesosuchus, Euparkeria*
	Peltaspermales	*Lepidopteris* *Dicroidium*	Anomodontia	*Kannemeyeria, Kombuisia, Ufudocyclops, Shansiodon*
	Ginkgoales	*Ginkgoites* *Sphenobaiera*	Therocephalia	*Microgomphodon, Bauria, Melinodon, Sesamodon, Watsoniella*

Group/subG/ Formation	Plant group	Genera	Animal Group	Genera
	Cycadales	*Pseudoctenis* *Nilsonia*	Cynodontia	*Cynognathus, Langbergia, Trirachodon, Lumkuia, Bolotridon, Diademadon, Cricodon*
	Coniferales	*Sewardistrobus*		
Group/sG/Fm	Plant Group	Genera	Animal Group	Genera
Stormberg; Molteno	Bryophyta	*Marchantium* *Muscites*	Pisces	*Ceratodon*
	Sphenophyta	*Phyllotheca,* *Neocalamites* *Schizoneura,* *Equisetites*	Cynodontia	*Cynognathus, Diademodon*
	Filicophyta	*Todites, Asterotheca* *Cladophlebis,* *Dictyophyllum*		
	Peltaspermales	*Dicroidium, Lepidopteris* *Yabiella, Taenopteris* *Dejerseya*		
	Cycadales	*Pseudoctenis, Nilssonopteris*		
	Ginkgoales	*Ginkgoites, Baiera*		
	Coniferophyta	*Rissikia, Heidiphyllum*		

Table information from Anderson and Anderson (1985); Anderson et al., (2020); Bamford (2004); Smith et al. (2020).

Appendix B – Examples of Tarkstad Subgroup and Molteno Formation fossils

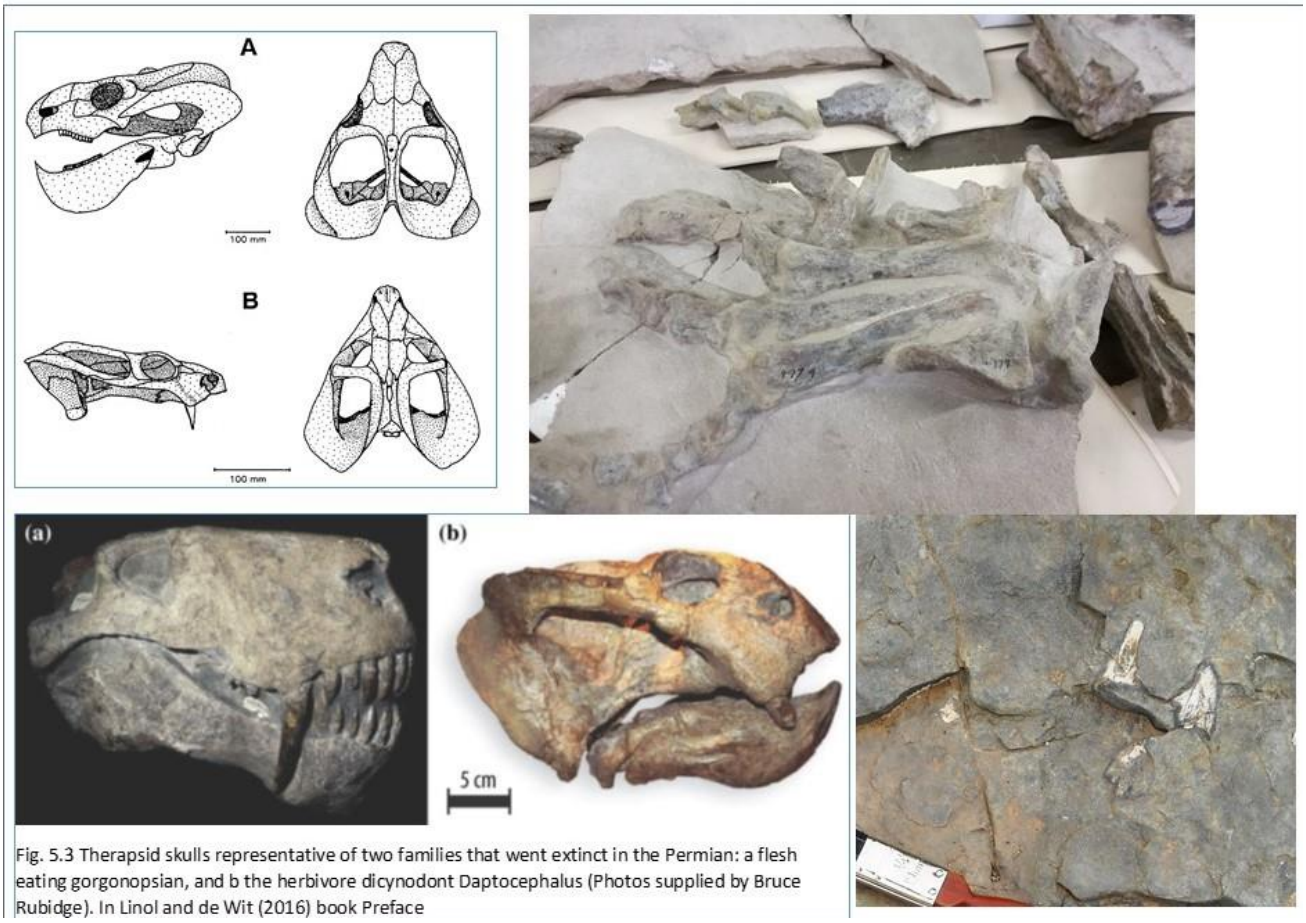

Figure 15: Various vertebrate fossils from the Tarkastad Subgroup. Botom right shows bones in situ as they are likely to be seen in the field.

Figure 16: Examples of *Dicroidium* seed ferns, typical of the Molteno Formation.

Appendix C – Site survey stops and GPS coordinates used in Table 3.

Smithfield-Rouxville-Zastron ESKOM PL – Fieldwork – 08-13 July 2021

Marion Bamford and Alisoun House for TheroServe
09 July with Paul Jansen of Eskom, Zastron

09 July - Day 1: Smithfield to Rouxville N6

Stop 1: Just passed Caledon River, Waterford B
30º 16' 49" S
26º 40' 1" E

Stop 2: near a koppie
30º 17' 12" S
26º 40' 41" E

Stop 3: Grootvlei, not cultivated, near outcrop close to crossover on N6
30º 18' 16" S
26º 41' 59" E

Stop 4: Past Eldorado Spruit, sandstone outcrop
a) 30º 19' 6" S
26º 42' 57" E
b) moving back down towards spruit, end of outcrop
30º 19' 2" S
26º 42' 54" E

Stop 5: Dolerite
30º 20' 31" S
26º 44' 33" E

Stop 6: After Klein Spruit, field of termite mounds
30º 22' 20" S
26º 46' 36" E

Stop 7: Enon, Line to cross over N6?
30º 23' 36" S
26º 48' 7" E

Stop 8: Rouxville, Vodacom tower, road crossing (dirt road)
30º 25' 16" S
26º 49' 5" E

Stop 9: road crossing on N6, towards Aliwal North, small dam on LHS
30º 25' 40" S
26º 49' 41" E

Stop 10: Rouxville Substation, road crossing (dirt road)
30º 25' 44" S
26º 50' 23" E

Stop 11: Road crossing, railway line, RHS, parallel to road, small dam LHS
30º 25' 14" S
26º 51' 13" E

Rouxville to Zastron R26

Stop 12: Road crossing, R26, NE Rouxville
30º 24' 10" S
26º 51' 16" E

Stop 13: Molteno outcrop, koppie
30º 20' 21" S
26º 58' 16" E

Stop 14: Sadowa (331), routed around farmhouse, windmill RHS
30º 17' 47" S
27º 0' 26" E

Stop 15: Road crossing, past Aasvoelkrans
30º 16' 16" S
27º 4' 2" E

Stop 16: Road crossing (intersection), turn off to Zastron R26, back of Aasvoelkrans
30º 16' 31" S
27º 4' 39" E

Stop 17: Zastron Substation
30º 17' 16" S
27º 4' 42" E

Return trip: Rouxville to Smithfield

Stop 18: Road cutting, siltstone, mudstone, red-grey, deep water
30º 17' 6" S
26º 40' 32" E

Day 2: Smithfield to Rouxville

Stop 19: Close to Smithfield, just over Groenspruit (picnic spot)
30º 14' 38" S
26º 33' 55" E

Stop 20: Farm entrance, long row of Eucalyptus, field of termite mounds, natural grazing with wild antelope
30º 14' 49" S
26º 34' 9" E

Stop 21: Road T1230, natural grazing
30º 16' 8" S
26º 36' 39" E

Stop 22: Road T1231, natural grazing
30º 16'43" S
26º 38' 17" E

Stop 23: Road S334 (RHS) Vodocom tower, red grass
30º 17' 23" S
26º 40' 48" E

Stop 24: Farm entrance, wagon wheels in gate, past Eldoradospruit and S335/6
30º 20' 24" S
26º 44' 26" E

Stop 25: Field of termite mounds on N6

30º 21' 7" S
26º 45' 13" E

Stop 26: Kleinspruit, natural grazing
30º 22' 10" S
26º 46' 25" E

Stop 27: Road T1253, natural grazing
30º 23' 13" S
26º 47' 38" E

Day 3: Rouxville to Zastron

Stop 28: Bedrock, distant windmill and little gulley (LHS), natural grazing, termite mounds (RHS)
30º 23' 58" S
26º 51' 41" E

Stop 29: Distant house with dam (LHS), open field (RHS)
30º 23' 8" S
26º 52' 41" E

Stop 30: Line crossing – overview
30º 22' 36" S
26º 53' 15" E

Stop 31: Service power line (RHS), open fields both sides
30º 21' 34" S
26º 54' 13" E

Stop 32: Farm, Poplars, red building (LHS), big Eucalyptus RHS, termite mounds
30º 20' 52" S
26º 56' 43" E

Stop 33: Molteno hill, road cutting (RHS)
30º 20' 19" S
26º 58' 23" E

Stop 34: Egyptian geese stop
30º 18' 35" S
26º 59' 17" E

Stop 35: Small ridge (LHS), Aasvoelkrans (RHS), past the farm
30º 16' 24" S
27º 2' 46" E

Day 4 – Rouxville environs

Stop 36: picnic spot, (on the out of Rouxville)
30º 19' 20" S
26º 59' 13" E