Palaeontological Impact Assessment for the proposed Transnet MPP Access Roads Inland sites Gauteng Province

Site Visit Report (Phase 2)

For

ENVASS

19 April 2022; revised 21 July 2022

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 33 years research; 25 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by ENVASS Group of Companies, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed construction of permanent accesses to the Multi Products Pipeline Infrastructure sites located between Free State (Harrismith) and Gauteng (Heidelberg). The applicant is Transnet.

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 site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development.

Most proposed permanent access routes are on non-fossiliferous dolomite or older rocks but four roads will be on potentially very highly fossiliferous rocks of the Vryheid and Normandien Formations (Karoo Supergroup). The site visits on 8th and 27-29th March 2022 confirmed that there were no fossils visible on the surface or in the gullies. Nonetheless, 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, developer, environmental officer or other designated responsible person once excavations and construction activities have commenced. Since the impact will be very low, as far as the palaeontology is concerned, the project should be authorised. No action is required before the construction phase.

Table of Contents

1. Background

In order to cope with the growing economic demand for petroleum products, particularly in Gauteng, Transnet constructed the Multi Products Pipeline (MPP 24") that will ultimately replace the existing Durban to Johannesburg Pipeline (DJP), providing a greater capacity and flexibility of the existing pipeline networks.

The strategically important MPP 24" Project and interrelated pipelines totals approximately 545km and includes new pump stations and delivery depots throughout the KwaZulu-Natal, Free State, Gauteng and Mpumalanga Provinces. The new pipelines were engineered and installed in accordance with internationally accepted standards and procedures, as well being cognizant of South African regulations.

In order for Transnet to conserve an environmentally sound and economically effective service on-going maintenance and monitoring of the MPP 24" is an imperative. The nature of the permanent servitude is such that accessing infrastructure during maintenance and monitoring activities presents numerous challenges that require permanent interventions to mitigate any environmental impacts that could be caused by accessing the servitude and to ensure that maintenance crews are able to access various portions of the pipelines during any condition. "Permanent Accesses" are seen as the most environmentally and economically effective solution for accessing Transnet's infrastructure.

The MPP 24" project is comprised of the following interrelated pipeline networks:

Main Trunk-line – Durban to Jameson Park
A new trunk-line (main pipeline) was constructed between a new coastal refined products terminal in Durban, KwaZulu-Natal located in the proximity of the Durban harbour and a new inland products terminal forming part of the Inland Network located at Jameson Park, Gauteng province. The trunk-line covers a distance of approximately 545 km and consists of a 24 inch (610 mm) diameter steel pipe and associated infrastructure.

The new pipeline is routed within a reserve around the southern proximity of Durban and converges with the existing DJP route in the proximity of Ashburton. The pipeline is then routed for approximately 245km in close proximity to the existing DJP Pipeline from Ashburton to Van Reenen. From Van Reenen the pipeline diverges from the existing reserve and is routed on an entirely new course to Jameson Park.

Transnet State Owned (SOC) Company (Ltd) has proposed development to gain access to the Multi Products Pipeline (MPP 24"). The MPP 24'' was constructed to cope with the growing economic demand for petroleum products. In order for the applicant to conserve an environmentally sound and economically effective service, the on-going maintenance and monitoring of the MPP 24" is an imperative. The nature of the permanent servitude is such that accessing infrastructure during maintenance and monitoring activities presents numerous challenges that require permanent interventions to mitigate any environmental impacts that could be caused by accessing the servitude and to ensure that maintenance crews are able to access various portions of the pipelines during

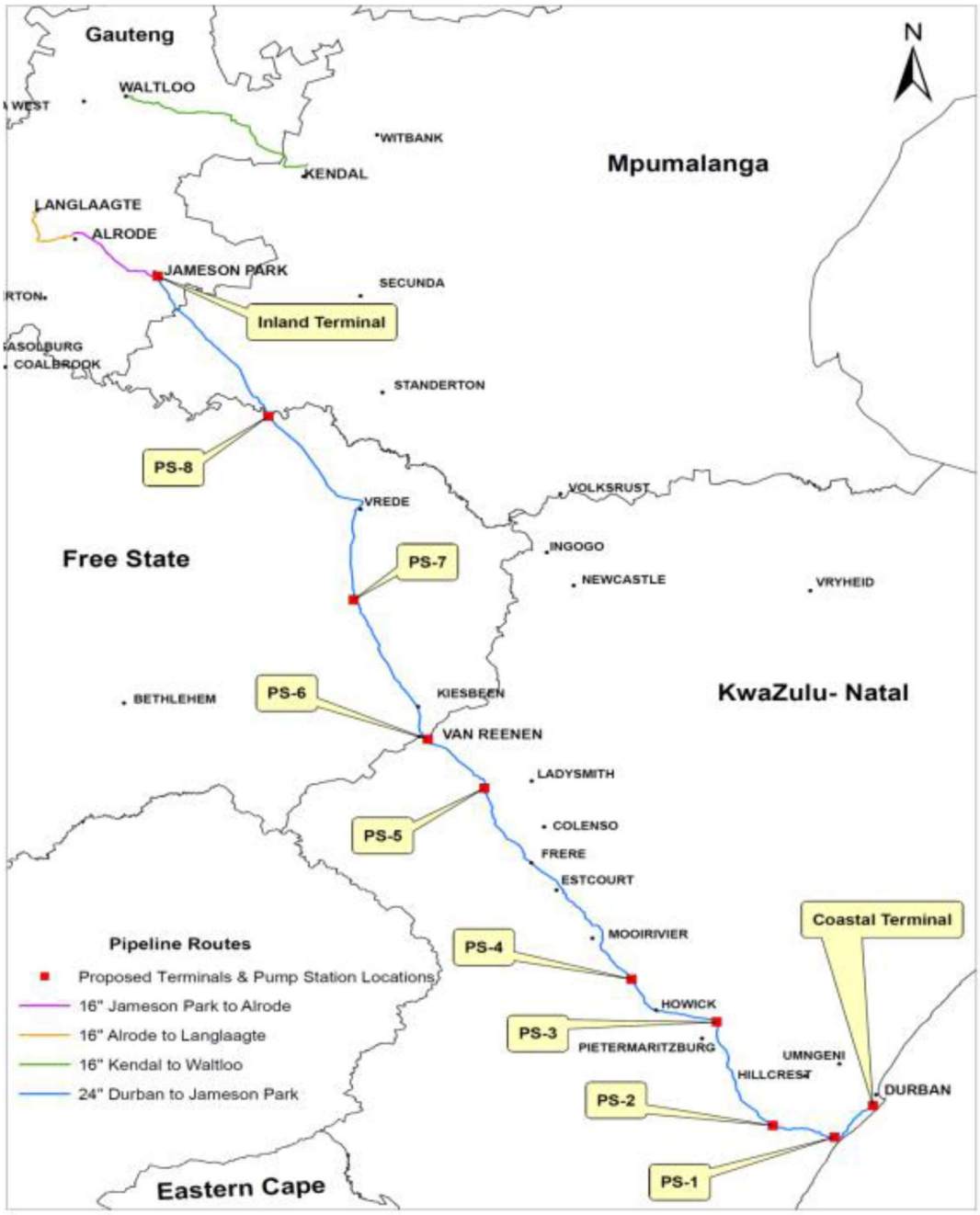


Figure 1: MPP24" pipeline route. This report covers the inland section from Jameson Park to Harrismith in the Free State and Mpumalanga sites.

maintenance activities. This scope of this work is for the application of environmental authorisation (.i.e. Basic Assessment) and Water Use License (WULA/GA) for the sites that are located between Free State (Harrismith) and Gauteng (Heidelberg).

In order to provide the entire network of lines with safe and secure access to the various assets that need to be subjected to maintenance and testing from time to time, it has been

identified that Transnet will require permanent structures to cross various watercourses located along the MPP 24". The required structures were not covered under the existing Water Use Licences or the existing Environmental Approvals. The structures can therefore not be constructed until the relevant processes and approvals have been obtained. It has been agreed that the application for a possible Water Use License and or Environmental Authorisation be pursued.

This report covers the **inland route** from Jameson Park to Harrismith (Figure 1 from Transnet)

A Palaeontological Impact Assessment was requested for the Inland Section of the Transnet MPP 24" permanent access roads 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 site visit and walkthrough (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A

	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	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
q	Any other information requested by the competent authority.	N/A

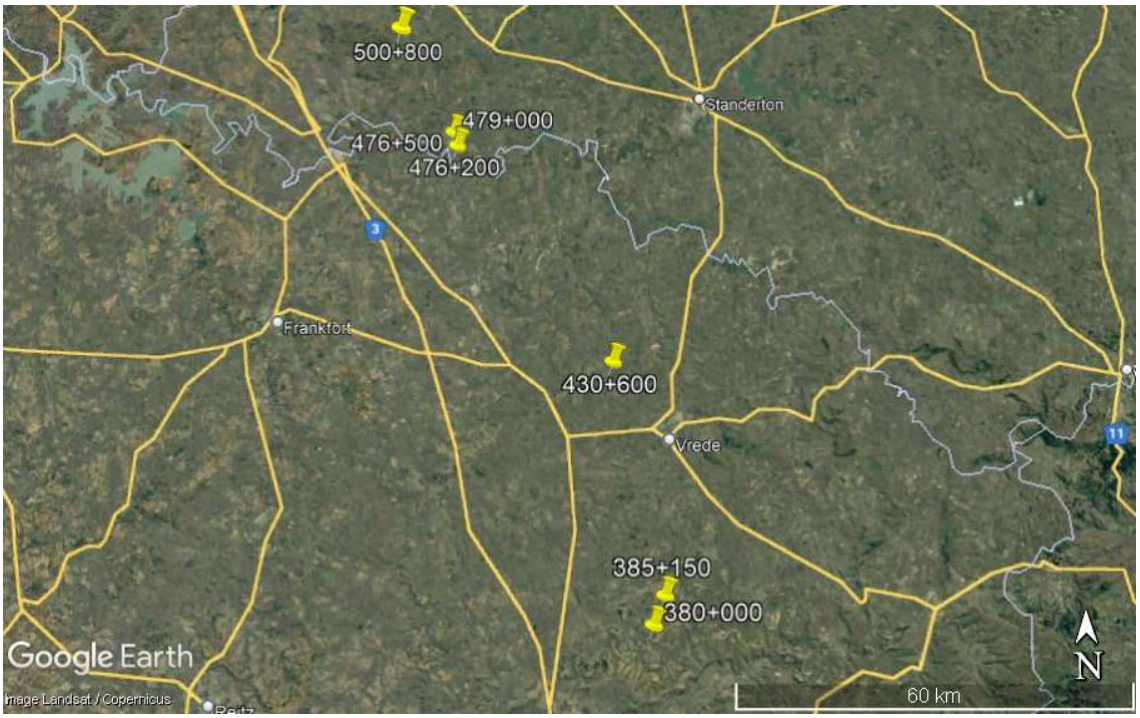


Figure 2: Google Earth map of the proposed Inland section access roads. See Table 3 for GPS coordinates.

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, as is the case here;
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

The pipeline route of the inland section is on ancient rocks close to Jameson Park and then on rocks of the Karoo Supergroup, ranging from Dwyka Group tillites in the more northerly part, through Vryheid Formation (Ecca Group) to the younger overlying Normandien Formation shales (Beaufort Group).

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.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the **Dwyka Group**. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled. This group has been divided into two formations with Elandsvlei Formation occurring throughout the basin and the upper Mbizane Formation occurring only in the Free State and KwaZulu Natal (Johnson et al., 2006).

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

Overlying the Ecca Group are the rocks of the Beaufort Group that has been divided into the lower Adelaide Subgroup for the Upper Permian strata, and the Tarkastad Subgroup for the Early to Middle Triassic strata. As with the older Karoo sediments, the formations vary across the Karoo Basin.

In the eastern part of the Karoo Basin, the Adelaide Subgroup comprises part of the Volksrust Formation that unconformably underlies the **Normandien Formation**. Previously known as the Estcourt Formation, the Normandien Formation has been divided into the Frankfort, Rooinekke, Schoondraai and Harrismith Members.

Large exposures of Jurassic dolerite dykes occur throughout the area. These intruded through the Karoo sediments around 183 million years ago at about the same time as the Drakensberg basaltic eruption.

Google Earth site maps, geological maps and SAHRIS palaeosensitivity maps for sensitive sites are provided in Figures 3- 9. The abbreviations of the rock types are explained in Table 2. Maps have been enlarged from the Geological Survey 1: 250 000 maps as indicated in the figures.

Table 2: Explanation of symbols for all the geological maps and approximate ages (Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pne	Normandien Fm (previously Estcourt Fm), Beaufort Group, Karoo SG	Grey shales, mudstone, fine-grained sandstone, rare coal	Late Permian
Pvo	Volksrust Fm, Ecca Group, Karoo SG	Grey-black shales, siltstones	Middle to Late Permian
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca
C-Pd	Dwyka Group, Karoo SG	Diamictites, tillites, mudstones	Late Carboniferous to Early Permian
Rk	Klipriviersberg Group, Ventersdorp SG	Andesite, tuff	Palaeoproterozoic, ca 2714 Ma

ii. Palaeontological context

The palaeontological sensitivity of the sites under consideration is presented in Figures 2-9 but the palaeontology for all strata is described below.

The Klipriviersberg Group rocks are of volcanic origin, namely andesites and tuffs, so they do not preserve fossils. The Jurassic dolerite is an intrusive volcanic rock, although much younger than the former, and it does not preserve fossils. Sites for access roads on these two strata were not visited.

The Karoo Supergroup sedimentary rocks are much more likely to preserve fossils although their precise distribution is unpredictable. The types of fossils from these strata is well documented.

The site for the project is in the **Dwyka Group** tillites, sandstone, mudstone and shales, and these potentially could preserve fossils. Around 300-290 Ma the climate in southern Africa was still relatively cool, but there were well developed Carboniferous floras in the northern hemisphere. In South Africa, however, much of the land surface was covered by ice sheets. As they melted they dropped the moraine trapped in the ice, together with limited plant matter from the vegetation that gradually recovered and colonised the land surface. Terrestrial vertebrates had not evolved at this time. The late Carboniferous flora

comprised *Glossopteris* leaves and seeds, wood, and other plants such as lycopods, sphenophytes and ferns.

The **Vryheid Formation** lies on the uneven topography of pre-Karoo or Dwyka Group rocks in the northern and northwestern margins, but lies directly on the Pietermaritzburg Formation in the central and eastern part. The lithofacies show a number of upward-coarsening cycles, some very thick, and they are essentially deltaic in origin. There are also delta-front deposits, evidence of delta switching, and fluvial deposits with associated meandering rivers, braided streams, back swamps or interfluves and abandoned channels (Cadle et al., 1993; Cairncross, 1990; 2001; Johnson et al., 2006). Coal seams originated where peat swamps developed on broad abandoned alluvial plains, and less commonly in the backswamps or interfluves. Most of the economically important coal seams occur in the fluvial successions (ibid). In the east (Mpumalanga and northern KwaZulu Natal), the Vryheid Formation can be subdivided into a lower fluvial-dominated deltaic interval, a middle fluvial interval, and an upper fluvial-dominated deltaic interval again (Taverner-Smith et al., 1988). The *Glossopteris* flora is typical of this stratum and includes glossopteris leaves and reproductive structures, lycopods, sphenophytes and ferns.

The **Volksrust Formation** is the upper part of the Ecca Group and is predominantly argillaceous and the grey to black silty shale with thin, usually with bioturbated siltstone or sandstone lenses and beds that occur mostly in the upper and lower boundaries. The very thick and fin-grained sediments represent an open shelf environment where muds were deposited from suspension (Johnson et al., 2006) in a deep water environment. It is not known if this was an inland sea or open marine setting but the discovery of the marine bivalve, *Megadesmus*, (albeit one instance) about 25km west southwest of Newcastle in Volksrust Formation shales, points to a marine influence for at least part of the sequence (Cairncross et al., 2005).

The **Normandien Formation** is in the upper part of the Beaufort Group. Previously known as the Estcourt Formation, it has fossil plants of the Glossopteris flora (Plumstead, 1969; Anderson and Anderson, 1985; Claassen, 2008; Prevec et al., 2009). This flora includes *Glossopteris* leaves, glossopterid fructifications (*Arberiella sp. Eretmonia natalensis, Lidgettonia africana, Lidgettonia lidgettonioides, Lidgettonia* sp.) sphenophytes (*Phyllotheca australis, Sphenophyllum speciosum, Schizoneura africana*), silicified wood of *Agathoxylon* spp. and rare lycopods. Vertebrates are extremely rare in this lithofacies.

iii. Site visit observations

Not all sites were visited because they are not all on fossiliferous rocks. Each site from the Google Earth kmz file was assessed for sensitivity. The co-ordinates, geology and palaeontological sensitivity for each site is listed in Table 3. According to the SAHRIS palaeosensitivity grading only the very highly sensitive and highly sensitive sites were visited on 8th and 27-29th March 2022. The SAHRIS grading, shown as background colours, indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue/purple = low; grey = insignificant/zero.

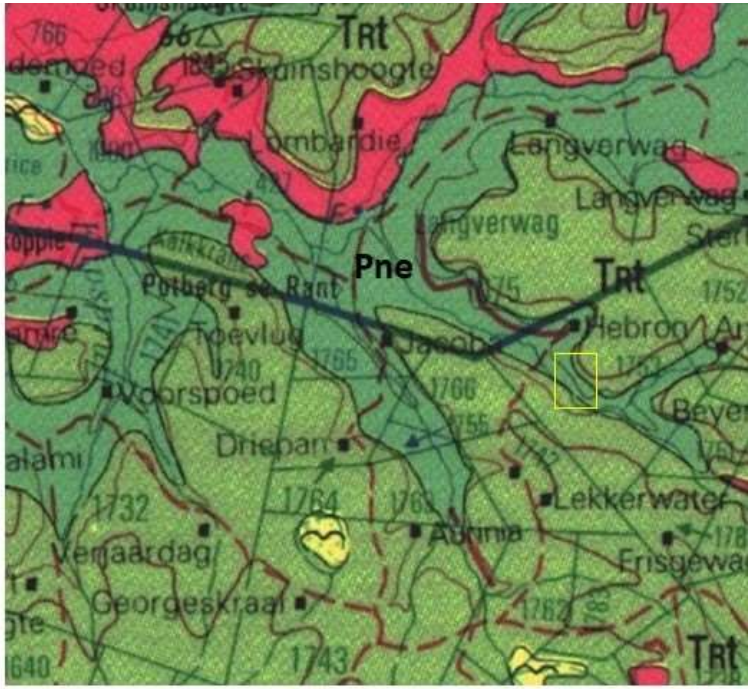
In summary, the sites on volcanic rocks, in this region the Klipriviersberg Group and Jurassic dolerite, were not visited. The sites on sedimentary rocks of the Karoo Supergroup that are indicated as very highly sensitive (red) and highly sensitive (orange) were visited (Table 3). Some orange sites were visited when they occurred close to the red sites

The selected sites were visited and walked through by palaeontologists who looked for any signs of rocky outcrops that could preserve fossil plants. Photographs were taken and observations are recorded in Table 3.

All sites were very disturbed as there are already tracks and dirt roads and in some cases the culverts in or along the wetlands are in place but in a poor state. This summer has been unusually wet so it provided an ideal opportunity to see the extent of the wetlands.

Table 3: Results and observations of the Inland MPP proposed permanent access road site visits to selected access roads, GPS co-ordinates, geology, palaeontology and relevant figures. Photographs taken by Rick Tolchard and Bailey Weiss

Site Name	Class	Co-ords	Geology and Palaeontology	SAHRIS Visit/not	Figures	Province
380+000 WFP (south)	Class C Moderately Modified	27° 43' 27" 29° 07' 07"	Normandien Fm; potentially *Glossopteris* flora. Open grassland, deep soils, no rocky outcrops and no fossils on the surface	Red; yes	3, 4a-c	Free State
385+150 RIV	Class D Largely Modified	27° 41' 07.58" S 29° 08' 15.51"E	Normandien Fm; potentially *Glossopteris* flora. Open grassland, deep to shallow soils, no rocky outcrops and no fossils on the surface	Red; yes	4d, 5, 6	Free State
430+600 RIV	Class C Moderately Modified	27° 21' 36,23" 29° 03' 58.99"	Normandien Fm; potentially *Glossopteris* flora. Low level bridge with masses of dead trees banked u against the culverts. The approach road is compacted soils and gravels; no rocky outcrops and no fossils on the surface	Red; yes	7; 8a-b	Free State
476+200 WHS	Class B/C Largely Natural to Moderately Modified	27° 01' 44.28" 28° 48' 57.10"	Jurassic dolerite so no fossils. Visited because very close to other road sites. Compacted soils and no outcrops	Grey	9	Mpumalanga
476+500 WHS	Class C Moderately Modified	27° 01' 44.28" 28° 48' 57.10"	Jurassic dolerite so no fossils. Visited because very close to other road sites. Compacted soils and no outcrops	Grey	9	Mpumalanga
479+000 RIV	Class C Moderately Modified	27° 00' 23.86" 28° 28' 35.86"	Volksrust Fm; potentially bivalves or fragmentary *Glossopteris* fossils. Grassland with no rocky outcrops and no fossils.	Orange; yes (close to red/visited site)	9	Mpumalanga
500+800 WFP (north)	Class C/D Moderately to Largely Modified	26° 50' 40.39" 25° 43' 07.88"	Volksrust Fm; potentially *Glossopteris* flora. Open grassland, deep soils, no rocky outcrops and no fossils on the surface.	Red; yes	8c-d, 10	Mpumalanga



Site No: 380+000

A - Google Earth map

B - Geology map: Jd = Jurassic dolerite; Trt = Tarkastad Subgroup; Pne = Normandien Fm.

C – SAHRIS palaeosensitivity map.; red = very highly sensitive.

Figure 3: Annotated maps for site No 380+00.

Figure 4A-C. Site 380+000 WPF; Normandien Formation. D – 385+150RIV Normandien Formation.

Figure 5: Site 385+150 RIV; Normandien Formation.

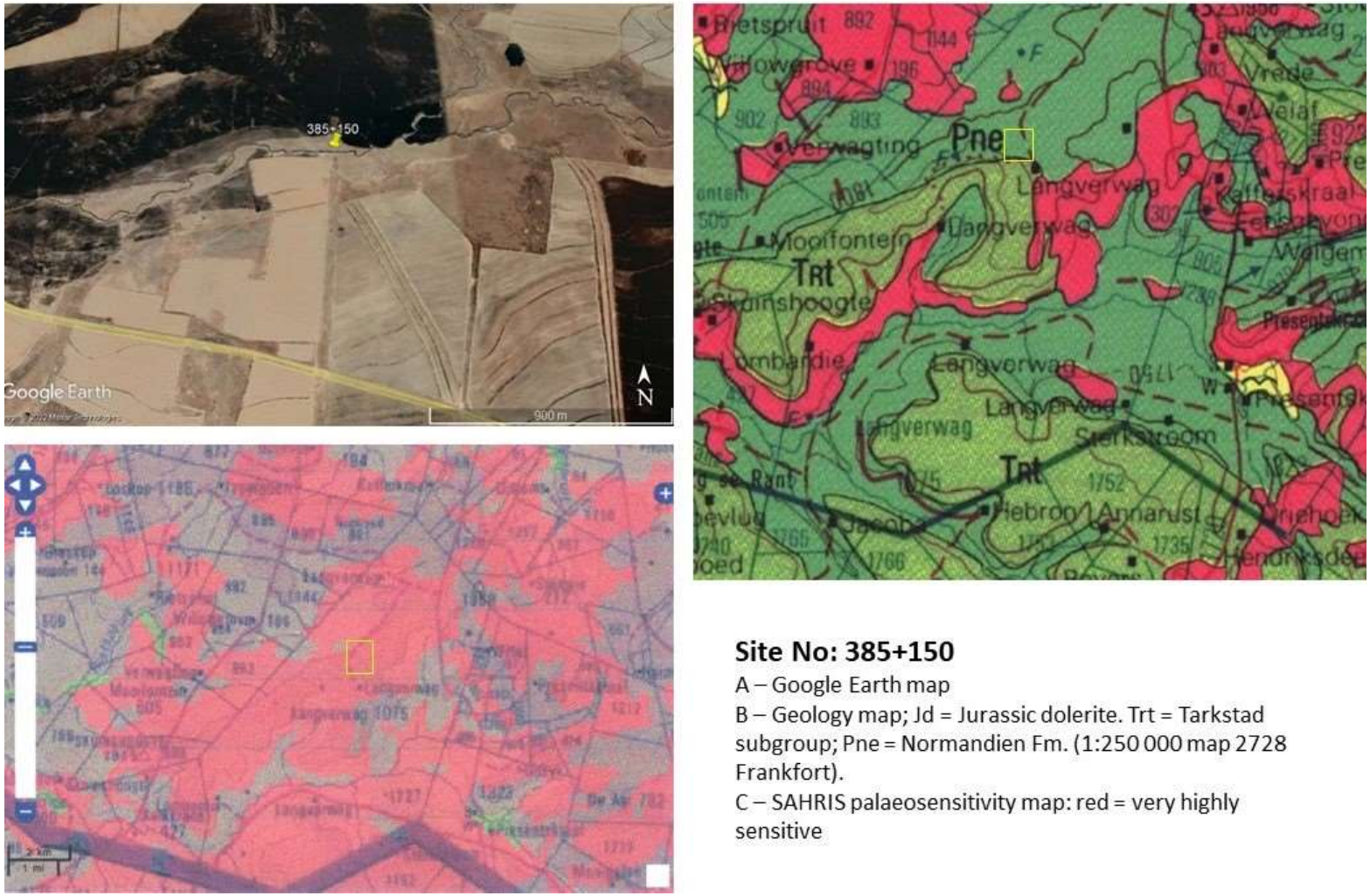


Figure 6: Annotated maps for site No 385+150.

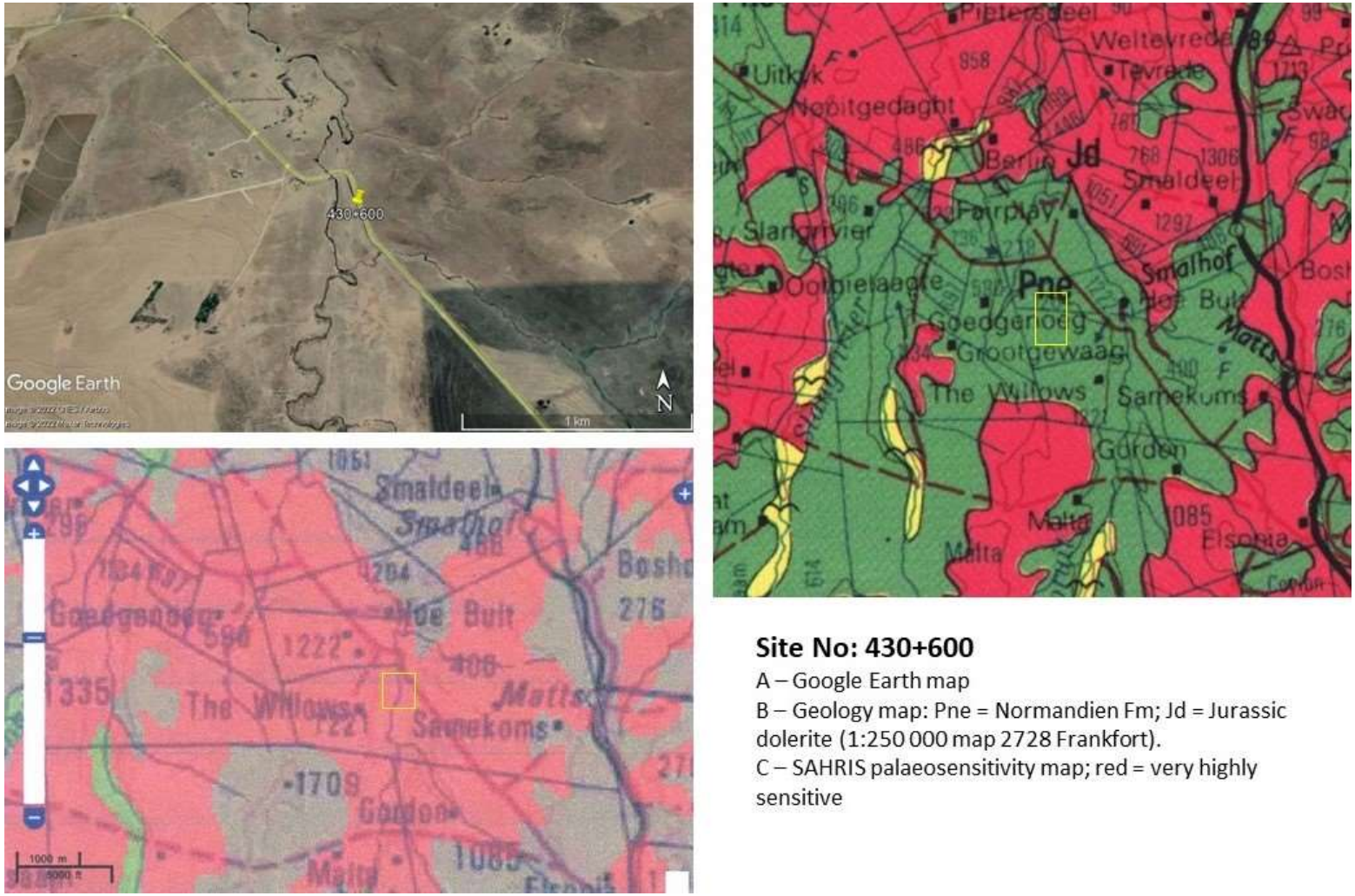
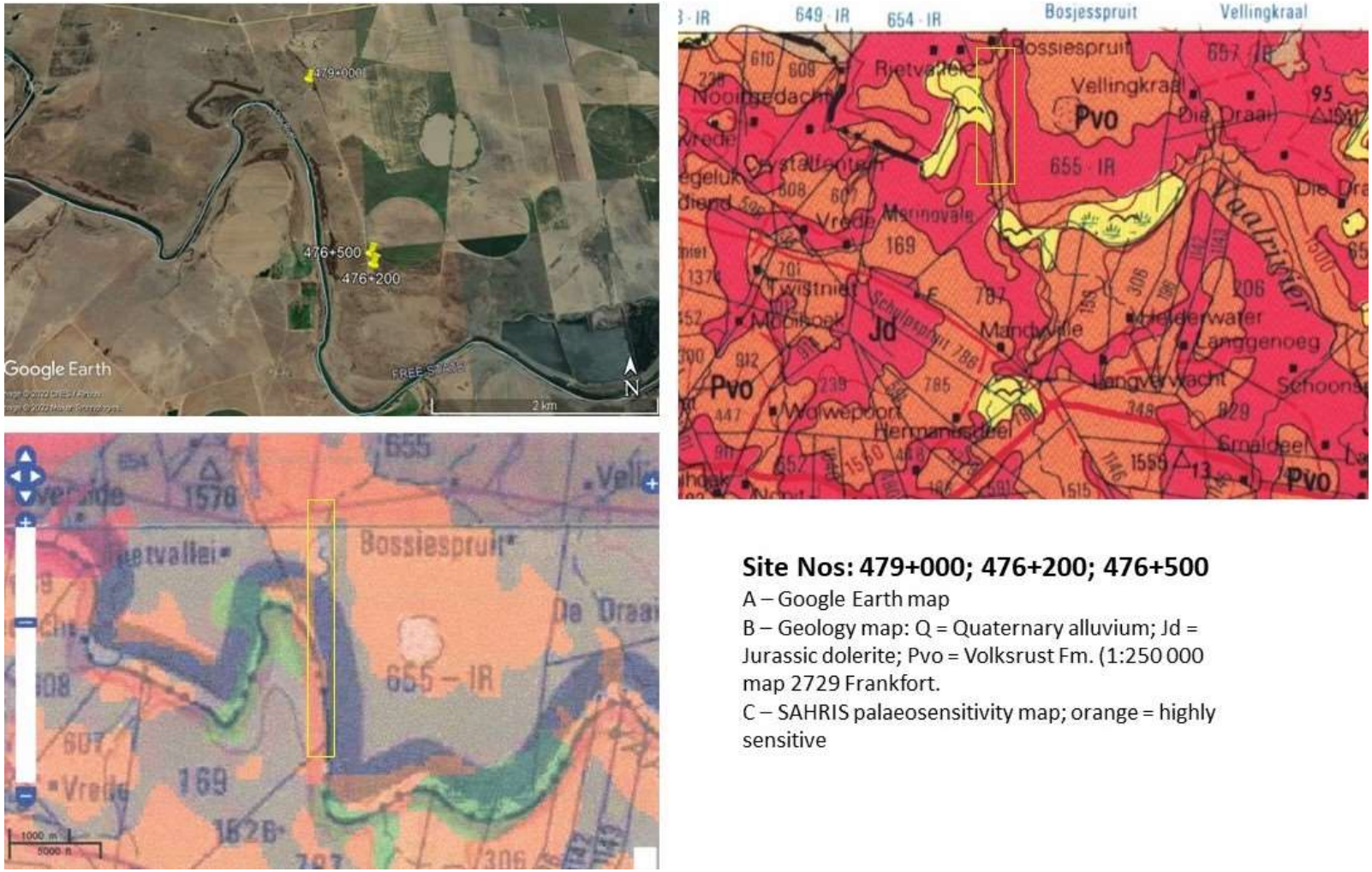


Figure 7: Annotated maps for site No 430+600.

Figure 8A-B: Site 430+600 RIV; Normandien Formation. C-D – site 500+800 WFP; Volksrust Formation.



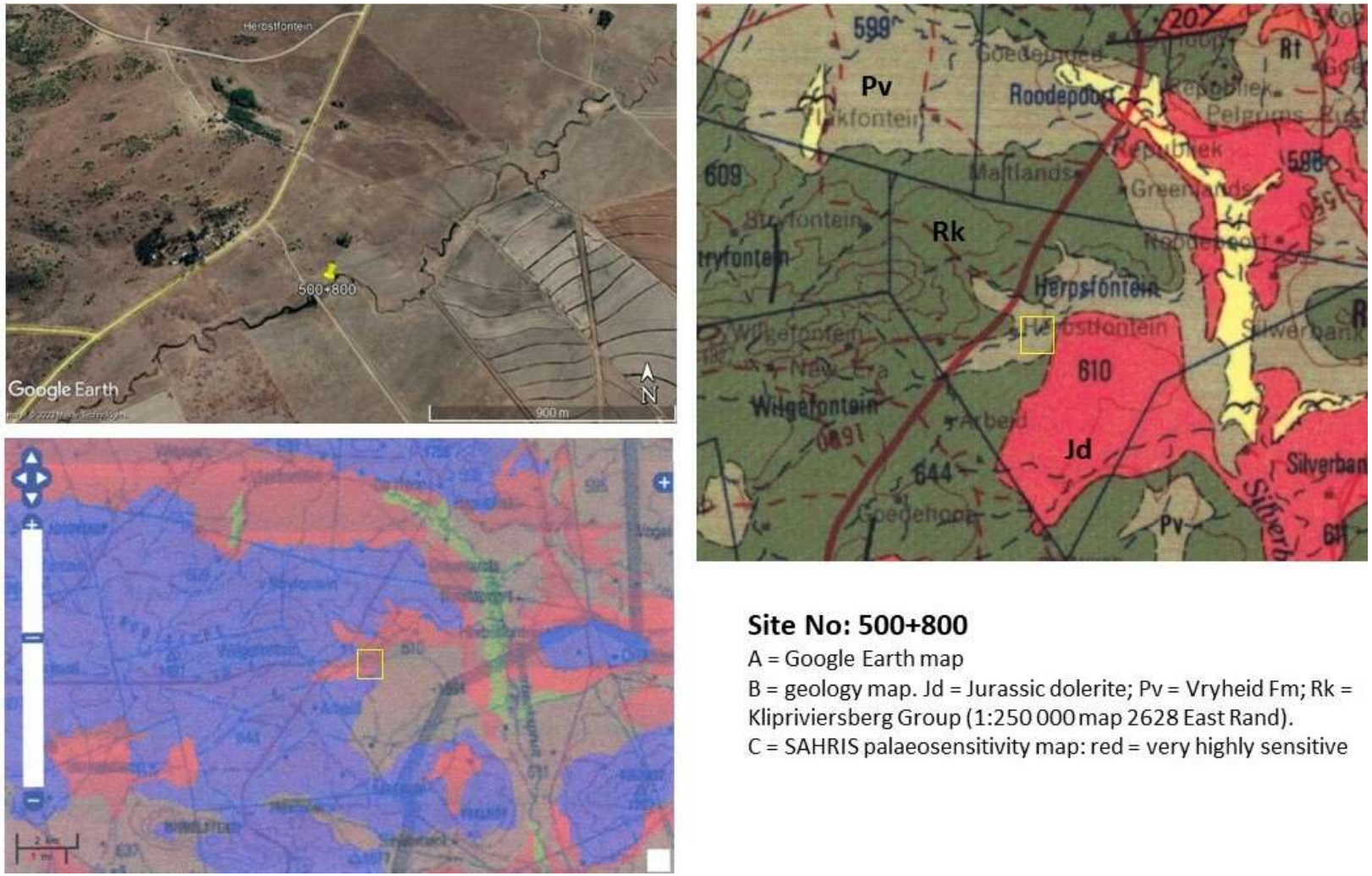
Site Nos: 479+000; 476+200; 476+500

A – Google Earth map

B – Geology map: Q = Quaternary alluvium; Jd = Jurassic dolerite; Pvo = Volksrust Fm. (1:250 000 map 2729 Frankfort.

C – SAHRIS palaeosensitivity map; orange = highly sensitive

Figure 9: Annotated maps for site Nos 479+000; 476+200; 476+500.



Site No: 500+800

A = Google Earth map

B = geology map. Jd = Jurassic dolerite; Pv = Vryheid Fm; Rk = Klipriviersberg Group (1:250 000 map 2628 East Rand).

C = SAHRIS palaeosensitivity map: red = very highly sensitive

Figure 10: Annotated maps for site No 500+800.

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 and volcanic material do not preserve plant fossils; so far there are no records from the Vryheid, Volksrust and Normandien Formations of plant or animal fossils in these sites region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-

PART B: Assessment		
	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 plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	It is extremely unlikely that any fossils would be found in the loose sand or soils that will be excavated. It is not known what is below the surface, therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.
	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 preserve fossils. The site visit and walk through confirmed that there were NO FOSSILS in the project footprint. Furthermore, the material to be excavated is soil and this does not preserve fossils. Since there is an extremely small chance that fossils from the Vryheid, Volksrust or Normandien Formations that occur below the ground surface, 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 extremely low to low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and some strata do contain fossil plant, insect, invertebrate and vertebrate material. The site visit and walk through on 8th and 27-29th March 2022 by palaeontologists confirmed that there are NO FOSSILS on the land surface, and no rocky outcrops that could potentially preserve fossils. It is not known what lies below the ground but in wetlands fossils are unlikely to occur since they would have been badly weathered. The sands of the Quaternary period would not preserve fossils.

6. Recommendation

Based on the fossil record but confirmed by the site visit and walk through there are NO FOSSILS of the *Glossopteris* flora even though fossils have been recorded from rocks of a

similar age and type in South Africa. It is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur in below the ground surface in the shales of the Vryheid or Normandien Formations so a Fossil Chance Find Protocol should be added to the EMPr for some sites (see Table 5). If fossils are found by the environmental officer, or other responsible person once excavations and drilling have commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample. No action is required before the construction phase.

Table 5: Summary of recommendations for the proposed permanent access roads for the inland MPP 24" pipeline. FCFP = Fossil Chance find Protocol described in Section 8 with photographs of types of fossils in Appendix A.

Wetland site	**Geology and Palaeontology**	**Recommendation**
380+000 WFP (south)	Normandien Fm; *Glossopteris* flora	FCFP during construction
385+150 RIV	Normandien Fm; *Glossopteris* flora	FCFP during construction
430+600 RIV	Normandien Fm; *Glossopteris* flora	FCFP
476+200 WHS	Jurassic dolerite	Proceed
476+500 WHS	Jurassic dolerite	Proceed
479+000 RIV	Volksrust Fm; *Glossopteris* flora, possible bivalves	FCFP during construction
500+800 WFP (north)	Vryheid Fm; *Glossopteris* flora	FCFP during construction

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.

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

Cadle, A.B., Cairncross, B., Christie, A.D.M., Roberts, D.L., 1993. The Karoo basin of South Africa: the type basin for the coal bearing deposits of southern Africa. International Journal of Coal Geology 23, 117-157.

Cairncross, B. 1990. Tectono-sedimentary settings and controls of the Karoo Basin Permian coals, South Africa. International Journal of Coal Geology 16: 175-178.

Cairncross, B. 2001. An overview of the Permian (Karoo) coal deposits of southern Africa. African Earth Sciences 33: 529–562.

Cairncross, B., Beukes, N.J., Coetzee, L.L., Rehfeld, U., 2005. The Bivalve *Megadesmus* from the Permian Volksrust Shale Formation (Karoo Supergroup), northeastern Karoo Basin,

South Africa: implications for late Permian Basin development. South African Journal of Geology 108, 547-556.

Claassen, M., 2008. A note on the biostratigraphic application of Permian plant fossils of the Normandien Formation (Beaufort Group, Northeastern Main Karoo Basin), South Africa. South African Journal of Geology 111, 263-280.

Isbell, J.L., Henry, L.C., Gulbranson, E.L., Limarino, C.O., Fraiser, F.L., Koch, Z.J., Ciccioli, P.l., Dineen, A.A., 2012. Glacial paradoxes during the late Paleozoic ice age: Evaluating the equilibrium line altitude as a control on glaciation. Gondwana Research 22, 1-19.

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.

Prevec, R, Labandeira, C.C., Neveling, J., Gastaldo, R.A., Looy, C., Bamford, M., 2009. Portrait of a Gondwanan ecosystem: A new Late Permian locality from KwaZulu-Natal, South Africa. Review of Palaeobotany and Palynology 156, 454-493.

Taverner-Smith, R., Mason, T.R., Christie, A.D.M., Smith, A.M., van der Spuy, M., 1988. Sedimentary models for coal formation in the Vryheid Formation, northern Natal. Bulletin of the Geological Survey of South Africa, 94. 46pp

Visser, J.N.J., 1986. Lateral lithofacies relationships in the glacigene Dwyka Formation in the western and central parts of the Karoo Basin. Transactions of the Geological Society of South Africa 89, 373-383.

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

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, fossils of plants, insects, bone or coalified material) 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 11-12). 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 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.

9. Appendix A – Examples of fossils from the Karoo Supergroup.

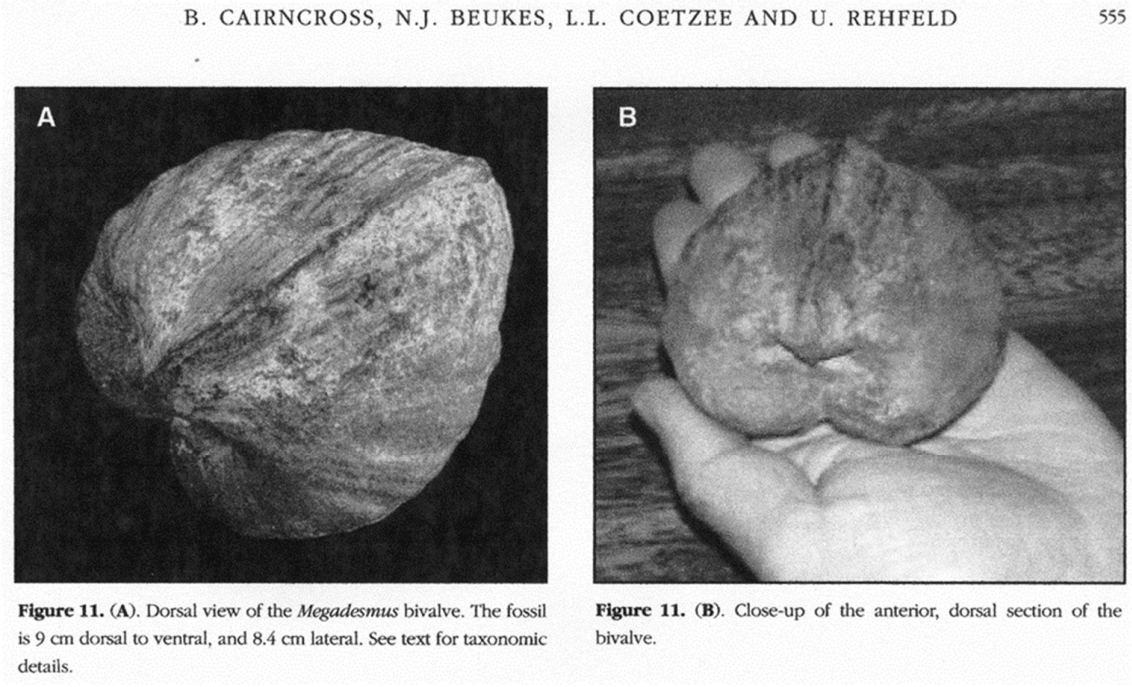


Figure 11: Bivalve *Megadesmus* from the Volksrust Formation (from Cairncross et al., 2005)

Figure12: Photographs of fossil plants from the *Glossopteris* flora

10. Appendix B – Details of specialists

Marion Bamford (PhD)

Short CV for PIAs – Jan 2022

I) **Personal details**

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	12	4
PhD	11	4
Postdoctoral fellows	12	2

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 12 - 20 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 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 25 local and international journals

x) **Palaeontological Impact Assessments**

Selected from recent project only – list not complete:

- 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

- 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 2021 for AHSA

Xi) **Research Output**
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google Scholar h-index = 36; -i10-index = 95
Conferences: numerous presentations at local and international conferences.

Mr Frederick Tolchard
Brief Curriculum Vitae – March 2022

Academic training
BA Archaeology – University of the Witwatersrand, graduated 2015
BSc (Honours) Palaeontology – University of the Witwatersrand, 2017 with distinction
MSc Palaeontology – University of the Witwatersrand, 2018 – 2019. Graduated 2020 with Distinction
PhD Palaeontology – Wits – 2020 - current

Field Experience
Honours Fieldtrip – Karoo biostratigraphy – April 2017
Research fieldwork – Elliot Formation with Prof Choiniere – April 2018, Nov 2018; April 2019; Sept 2021

Publications
Tolchard, F., Nesbitt, S.J., Desojo, J.B., Viglietti, P.A., Butler, R.J. and Choiniere, J.N., 2019. 'Rauisuchian' material from the lower Elliot Formation of South Africa: Implications for late Triassic biogeography and biostratigraphy. Journal of African Earth Sciences, 160, 103610.

Viglietti, P.A., McPhee, B.W., Bordy, E.M., Sciscio, L., Barrett, P.M., Benson, R.B.J., Wills, F., Tolchard, F., Choiniere, J.N., 2020. Biostratigraphy of the Scalenodontoides Assemblage Zone (Stormberg Group, Karoo Supergroup), South Africa. South African Journal of Geology 123, 239-248.

Tolchard F., Kammerer C., Butler R.J., Abdala F., Hendrickx C., Benoit J., Choinière J.N. (2021.) A very large new trirachodontid from the Triassic of South Africa and its implications for Gondwanan biostratigraphy. Journal of Vertebrate Paleontology. DOI: 10.1080/02724634.2021.1929265.

PIA fieldwork projects

2018 May – Williston area – SARAO project, Digby Wells
2018 September – Lichtenburg PVs – CTS Heritage
2018 November – Nomalanga farming – Digby Wells
2019 January – Thubelisha coal – Digby Wells
2019 March – Matla coal – Digby Wells
2019 March – Musina-Machado SEZ – Digby Wells
2019 June – Temo coal – Digby Wells
2019 September – Makapanstad Agripark – Plantago
2020 January – Hendrina, Kwazamakuhle – Kudzala
2020 February – Hartebeestpoort Dam - Prescali
2020 March – Twyfelaar Coal mine – Digby Wells
2020 March – Ceres Borrow Pits – ACO Associates
2020 March – Copper Sunset Sand – Digby Wells
2020 October – Belfast loop and Expansion – Nsovo
2020 October – VLNR lodge Mapungubwe – HCAC
2020 November – Delmore Park BWSS - HCAC
2020 December – Kromdraai commercial – HCAC
2021 January – Welgedacht Siding – Elemental Sustainability
2021 March – Shango Kroonstad – Digby Wells
2021 May – Copper Sunset sand mining – Digby Wells
2021 August – New Largo Pit – Golder
2021 August – Khutsong Ext 8 housing, Carletonville, for Afzelia
2021 September – Lichtenburg PV facility – CTS Heritage
2021 October – Ogies South MR – beyondgreen
2021 October – Nooitgedacht Colliery MR – Shangoni
2022 January – Sigma PVs Sasolburg – CTS Heritage
2022 March – Taaibosch Puts PVs – CTS Heritage
2022 March – Modder East Operations – Prime Resources
2022 March – Driefontein mine revised infrastructure – Amber Earth

Bailey M. Weiss CV
March 2022

I am currently enrolled as a PhD student, at the University of the Witwatersrand, Johannesburg. I completed my Masters degree at the University of the State (UFS), on: *Bone microanatomy of Anomodontia (Synapsida: Therapsida) from the Karoo Basin of South Africa*. This project was supervised by Dr Jennifer Botha (National Museum, Bloemfontein) and Co-Supervised by Dr Alexandra Houssaye (Muséum national d'Histoire naturelle, Paris). I completed my BSc honours degree in which I completed a research project entitled: *Limb bone histology of theropod dinosaurs from the Early Jurassic of South Africa*. This project was supervised by Dr Jennifer Botha. I majored in Genetics and Zoology for my BSc degree. I have worked as an Osteohistology Technician at the National Museum, Bloemfontein, as well as a Laboratory Assistant at the UFS. I have been on two Palaeontological field trips one with the National Museum in the Balfour and Katberg Formations. The other with the University of the Witwatersrand in the Lower Elliot Formation of South Africa.

Qualifications
BSc – Majors: Genetics and Geology - University of the Free State – 2018
BSc Honours – Palaeontology – University of the Free State – 2019
MSc – Palaeontology – University of the Free State – graduated 2021.
PhD – Palaeontology – University of the Witwatersrand – registered 2022.

PIA fieldwork Experience
July 2021 – Sannaspos PV Facility, Free State for CTS Heritage
October 2021 – Beatrix Mine-Theunissen Eskom powerline for 1World
March 2022 – Taaibosch Puts PV – for CTS Heritage
March 2022 – Modder East infrastructure – Prime Resources
March 2022 – Driefontein Mine infrastructure – AmberEarth
March 2022 – Transnet MPP Access routes, inland and coastal - ENVASS

References:
Dr Jennifer Botha, Head of Palaeontology, National Museum, Bloemfontein
jbotha@nasmus.ac.za

Prof Jonah Choiniere, Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg
Jonah.choiniere@wits.ac.za