Palaeontological Impact Assessment for the proposed construction of a dam wall on farm Bruintjieslaagte 465JT, in the Schoemanskloof Valley, Mpumalanga Province.

Desktop Study

For

Kudzala

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Expertise of Specialist

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Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 20 year PIA studies

Declaration of Independence

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

Specialist: …….. Prof Marion Bamford……..

Signature: …….

Executive Summary

The desktop Palaeontological Impact Assessment for the area in and around Schoemanskloof Valley and the farm Bruintjieslaagte 465 JT in particular has been completed. The rocks in the area are ancient sediments of the Timeball Hill Formation, Pretoria Group with nearby volcanic granites and gneisses of the Mpuluzi, Nelspruit and Kaapvaal plutons. They do not contain any fossils because they are igneous in origin and too old for body fossils. Microbial mats have been reported from slightly younger rocks, and also from the rocks of the Barberton Greenstone Belt which are mostly igneous and very old but microfossils have been found in the Fig Tree Formation. These rocks are too far away to be affected. There is a very small chance that trace fossils (ripple marks and microbial mats) could occur in the Bushveld Complex rocks but have not been recorded from this particular Formation so a “chance find” protocol has been added The palaeosensitivity map is probably inaccurate for this area. It is concluded that the project may continue as far as the paleontology is concerned and no further impact assessments are required.

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1. Background

A desktop palaeontological impact assessment has been requested for the proposed construction of an irrigation dam wall on the farm Bruintjieslaagte 465 JT. The farm is located in the Schoemanskloof valley approximately 40km west of Nelspruit, Mpumalanga. The dam will be built in a higher altitude area of the farm as shown in blue and the expected water-level is indicated in red on the google earth map (Fig. 1).

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 982 of 2014). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

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

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Prof Marion Bamford
The expertise of that person to compile a specialist report including a curriculum vitae	Palaeontologist (PhD Wits 1990) CV attached
A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
An indication of the scope of, and the purpose for which, the report was prepared	Section 1, page 3
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	n/a Seasons make no difference to fossils
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2, page 4
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	See table 2
An identification of any areas to be avoided, including buffers	n/a
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	n/a
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6, page 9
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	n/a
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, page 10

A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	n/a
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	n/a
A description of any consultation process that was undertaken during the course of carrying out the study	Section 3 page5
A summary and copies if any comments that were received during any consultation process	n/a
Any other information requested by the competent authority.	n/a

2. Methods and Terms of Reference

1. In order to determine the likelihood of fossils occurring in the affected area geological maps, literature, palaeontological databases and published and unpublished records must be consulted.

2. If fossils are likely to occur then a site visit must be made by a qualified palaeontologist to locate and assess the fossils and their importance.

3. Unique or rare fossils should either be collected (with the relevant South African Heritage Resources Agency (SAHRA) permit) and removed to a suitable storage and curation facility, for example a Museum or University palaeontology department or protected on site.

4. Common fossils can be sacrificed if they are of minimal or no scientific importance but a representative collection could be made if deemed necessary.

The published geological and palaeontological literature, unpublished records of fossil sites, catalogues and reports housed in the Evolutionary Studies Institute, University of the Witwatersrand, and SAHRA databases were consulted to determine if there are any records of fossils from the sites and the likelihood of any fossils occurring there.

In the case that fossils could be found when excavations commence, a “chance find” protocol has been added.

Figure 1: Locality of proposed dam wall (blue) and expected water level of the dam (red) on the farm Bruintjieslaagte 465JT, Schoemanskloof Valley, about 40km west of Nelspruit. Google Earth map supplied by Kudzala.

3. Consultation Process

No consultations were carried out during the palaeontological desktop study.

4. Geology and Palaeontology

Project location and geological setting

The site for the proposed dam wall lies on ancient rocks of the Timeball Hill Formation, Pretoria Group (Fig 2 and Table 2).

Geology

The rocks in this region have been well studied as they are amongst the oldest rocks in the world. To the south east in a northeast – southwest orientation are the oldest rocks, those of the Barberton Greenstone Belt. To the west in a more north-south orientation are the Bushveld Complex rocks of the Chuniespoort and Pretoria Supergroups, while in between are the granite batholiths and plutons of the mid Archean.

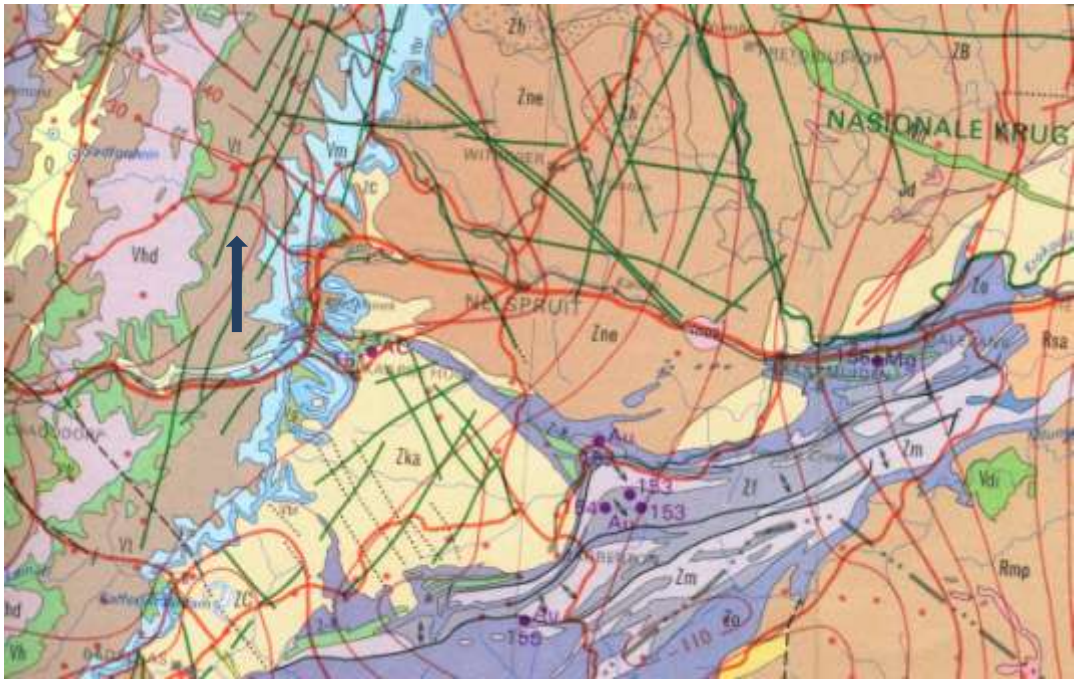

Figure 2: Geological map of the area around Schoemanskloof Valley, about 40km to the west of Nelspruit, where the Farm Bruintjieslaagte465JT is located. The approximate location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Brandl et al., 2006; Duncan and Marsh, 2006; Robb et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Aeolian sands	Last 2.5 Ma
Vsi	Silverton Fm, Pretoria Group	Basalt, tuff, shale	Ca 2150 Ma
Vhd	Dwaalheuvel, Strubenkop and Daspoort Fms; Pretoria Group	Andesite, sandstone, shale	
Vh	Hekpoort Fm, Pretoria Group	Basaltic andesite, pyroclastic rocks	2224 Ma
Vt	Timeball Hill and Rooihoogte Fm, Pretoria Group	Shale, quartzite, conglomerate, breccia, diamictite	Ca 2420 Ma
Vm	Malmani subgroup, Chuniespoort Group	Dolomite, chert	2642 – 2500 Ma
Vbr	Black Reef Fm	Quartzite, conglomerate, shale, basalt	>2642 Ma
Vg	Godwan Group	Clastic sedimentary and lesser volcanic rocks, massflow diamictites and	

Symbol	Group/Formation	Lithology	Approximate Age
		pyroclastic rocks	
Z-R	Unnamed ultrabasic rocks	Ultrabasic volcanic rocks	
Rmp	Mpuluzi Batholith (Mpuluzi Suite)	granites	Ca 3303 Ma
Zne	Nelspruit Batholith (Nelspruit Suite)	Gneiss, porphyritic granite	Ca 3303 Ma
Zh	Hebron pluton	granodiorite	Ca 3105 Ma
ZB	Unnamed potassic granite and granodiorite	granites	
ZC	Unnamed trondhjemitic and tonalitic gneiss	gneiss	
Zm	Moodies Group, Barberton Greenstone Belt, Barberton Supergroup	Conglomerate, sandstone, siltstone, shale	Ca 3225-3084 Ma
Zka	Kaap Valley Pluton	Tonalitic hornblende granite	3227 Ma
Zf	Fig Tree Group, Barberton Greenstone Belt, Barberton Supergroup	Greywacke, shale, chert and dacitic volcanic rocks	Ca 3461-3227 Ma
Zo	Onverwacht Group, Barberton Greenstone Belt, Barberton Supergroup	Ultramafic to mafic volcanic rocks	Archaean 3450 Ma

Palaeontology

(Refer to Figure 3 for SAHRIS palaeosensitivity map)

To the west are rocks of the Pretoria Group and the site is on the shale, quartzite, conglomerate, breccia and diamictites of the Timeball Hill Formation, Pretoria Group. There are two models proposed for the formation of the Pretoria Group, that of sedimentation in a shallow marine setting or deposition in a closed basin, but there are no invertebrate fossils to support the models. More recent workers have suggested that initially there was a closed basin (Rooihooghte to Strubenkop Formations) followed by alternating transgressive and regressive cycles in a shallow marine setting (Erikssen et al., 2006), or deep marine (Erikssen et al., 2012).

Trace fossils, in the form of microbial mats that have formed on or preserved ripple marks, have been found in the Daspoort and Magaliesberg Formations (underlying and overlying the Silverton Formation, respectively; Erikssen et al., 2012; Parizot et al., 2005) but they do not provide localities. According to the authors the trace fossils would have formed on the shores of the sea (Erikssen et al., 2012), but no body fossils have been found as the rocks are too old. To date no microbial mats have been reported from the Silverton Formation or from the Timeball Hill Formation so the SAHRIS palaeosensitivity map is questionable.

The Black Reef Formation and Malmani Subgroup banded ironstone and dolomites, although formed by the chemical activities of ancient algae, photosynthesis and oxygen production, are not known to have preserved fossil algae near Nelspruit.

Batholiths and plutons do not preserve any fossils as they are igneous in origin.
These particular ones, the Mpuluzi and Nelspruit batholiths are also too old to preserve fossils even if any life forms were around as they are over 3300 Ma. At this time there were only single-celled algae or bacteria present (Knoll, 1984).

There are also no records of fossils from the Quaternary alluvium in this region.

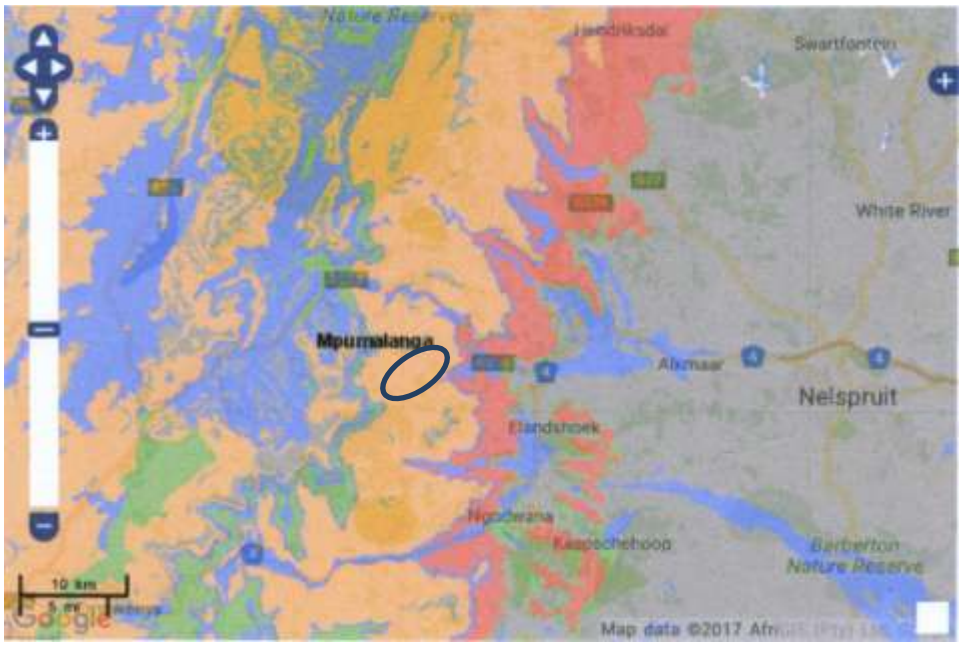

Figure 3: SAHRIS palaeosensitivity map. The proposed site for the dam wall is within the oval outline. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

5. Impact assessment

Using the criteria in the table below, the impact of the access to piping routes between boreholes has been assessed.

TABLE 3: 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

The surface activities would not impact on the fossil heritage as the rocks are ancient and volcanic so there are no fossils present. The IMPACT is nil (according to the scheme in Table 3).

Excavation for the roads to the dam wall site would penetrate only a few metres below ground surface at the most so there would be minor deterioration of the surface of sites and an impact on any potential fossils. Therefore the SEVERITY/NATURE of the environmental impact would be L.

DURATION of the impact would be permanent: H.

No fossils are likely to be found in the granites but if any were then the SPATIAL SCALE will be localised within the site boundary: L.

There is a very small chance of finding trace fossils on the surface as these have been reported from older and younger Formations, but not where the dam wall would be built. Thererfore, the PROBABILITY of affecting any fossils is unlikely or seldom: L

6. 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 basement rocks, dolomites, sandstones, shales, quartzites, basalts and gabbros are typical for the country and do not contain any fossil material. The sediments of the Silverton Formation could contain trace fossils of algal mats and ripple marks in sandstones, however, they have yet to be recorded from the Timeball Hill Formation on which the dam wall will be built.

7. Recommendation

It is extremely unlikely that any fossils occur in the sites for the proposed dam wall because mostly the rocks are much too old and volcanic in origin. Although there are rare reports of microbial mats from similar aged rocks, none has been reported from this particular Formation. Since there is a very small probability that trace fossils such as microbial mats could be found, a "chance find" protocol must be followed. This should be added to the EMPr.

As far as the palaeontology is concerned the proposed development can go ahead. Any further palaeontological assessment would be unnecessary.

8. Chance Find protocol

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar trace fossils, microbial mats, fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 4). 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. On a regular basis, to be agreed upon by the developer and the qualified palaeontologist sub-contracted for this project, the palaeontologist should visit the site to inspect the selected material and check the dumps where feasible. The frequency of inspections should be monthly. However, if the onsite designated person is diligent and extracts the fossil material then inspections can be less frequent.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until construction has ceased. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. References

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Noffke, N., Erikssen, K.A., Hazen, R.M., Simpson, E.L. 2006. A new window into Early Archean life: Microbial mats in Earth's oldest siliciclastic tidal deposits (3.2 Ga Moodies Group, South Africa). Geology 34, 253–256.

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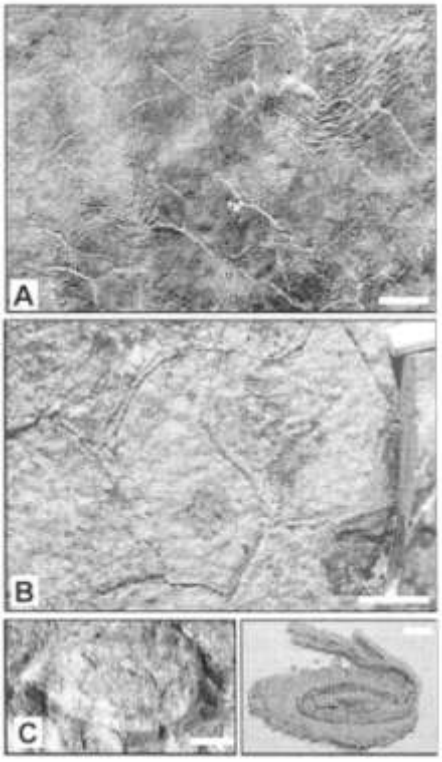

Figure 2. Microbially induced sedimentary structures (MISS), Moodies Group. A: Wrinkle structure and subsequently formed syneresis cracks on fine-grained sandstone bedding plane; scale: 10 cm. B: Wrinkle structure and desiccation cracks on sandstone bedding plane; scale: 2 cm. C: Roll-up structure; scale: 1 cm; for comparison, modern roll-up structure from tidal flats of Fishermans Island, Virginia, USA, is shown on right; scale: 1 cm.

Figure 4: Example of some microbial mats (Noffke et al., 2006).