Palaeontological impact Assessment for Shango Solutions (Pty) Ltd for the S102 Application for Fairview Mine, Barberton, Mpumalanga Province

Desktop (Phase 1) Study

Subcontracted by Beyond Heritage (Pty) Ltd

Report prepared by

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1. **Executive summary**.

A palaeontological Impact Assessment was requested for the S102 application process. Barberton Mines wish to make changes to the mining right by adding a portion of the farm property Bramber 314 JU (formerly Bramber East 314 JU). This property also formed part of the initial environment impact assessment process. It is anticipated that the proposed addition will not result in a change of scope to the mining work programme. Therefore, the inclusion of this property into the mining right will allow for the continuation of current and scheduled mining operations. The Fairview mine is located about 2 km northeast of the town of Barberton.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the ancient rocks of the Barberton Greenstone Belt and on ancient granite of the Kaap Valley Pluton. The latter pre-dates any life forms and has zero palaeosensitivity. The Barberton Greenstone Belt rocks have very low palaeosensitivity and only invisible microbes might be present. A Fossil Chance Find Protocol should be added to the EMPr and monitoring. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations, drilling or mining activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

The Environmental Significance Rating is Low negative pre-mitigation and Low positive post-mitigation where mitigation means the removal of any fossils. There is no no-go area, there are no preferred alternatives and there are no cumulative impacts.

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2. **Declaration of independence and summary of expertise**.

Declaration
This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage (Pty) Ltd, Modimolle, 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: 

Expertise
The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 34 years research and lecturing in Palaeontology
26 years PIA studies and over 350 projects completed

3. Specialist declaration of independence and statement of objectivity for the assessment.

Declaration of Independence
I, Marion Bamford, declare that –
General declaration:

- I act as the independent palaeontology practitioner in this application,
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant,
- I declare that there are no circumstances that may compromise my objectivity in performing such work,
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation,
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application,
- I have no, and will not engage in, conflicting interests in the undertaking of the activity,
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority,
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application,

- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct,
- I will perform all other obligations as expected from a heritage practitioner in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realise that a false declaration is an offence in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

4. Summary of the specialist's expertise

I, Marion Bamford, am a professional Palaeontologist with a PhD in Palaeontology (Wits University, 1990). I have more than 30 years of experience in palaeontological research and have published over 170 papers in peer-reviewed journals and published more than 10 scholarly book chapters. I review manuscripts for international and local journals and also review funding proposals for international funding bodies. Currently I am the Director of the Evolutionary Studies Institute, the only palaeontological institute in Southern Africa.

I have completed more than 350 palaeontological impact assessments (desktop and site visit studies) in the last 26 years for a variety of projects (solar energy projects, wind energy projects, powerlines, roads, infrastructure, housing and retail projects and from all over South Africa. I have been subcontracted by over 30 different companies. From my own projects and training provided by me and other staff in the ESI for Palaeontological Impact Assessments, I am familiar with the legislation.

5. Introduction.

Barberton Mines (Pty) Ltd (Barberton Mines), which forms part of Pan African Resources PLC, owns and operates the Fairview Mine near the town of Barberton in the Mpumalanga Province of South Africa. Mining in the area commenced in the 1880's. The mine is operated under a mining right (Reference Number MP 30/5/1/2/2/10221(191 MR) and an approved Environmental Management Programme (EMPr) issued by the Department of Mineral Resources and Energy (DMRE) in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA, as amended).

Barberton Mines wish to make changes to the mining right by adding a portion of the farm property Bramber 314 JU (formerly Bramber East 314 JU). The amendment application is required to address an administrative error that occurred at the time of execution of the right. The farm Bramber 314 JU was omitted in Annexure "A" to the mining right. However, it is included in the Regulation 42 Plan of the mining right. This property also formed part of the initial environment impact assessment process. It is anticipated that the proposed addition will not result in a change of scope to the mining work programme. Therefore, the inclusion of this property into the mining right will allow for the continuation of current and scheduled mining operations.

6. **Scope of work (based on terms of reference**).

This report is for the palaeontological impact assessment that is required as part of the S102 mining amendment application and follows the terms of reference as listed below.

7. **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:

a. Literature Review

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; eg https://sahris.sahra.org.za/map/palaeo

b. Fieldwork

- Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (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' representativity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (applicable to this assessment).

c. Data Analysis

No fossils were found so there was no data to analyse

8. Legislative and policy framework.

According to NEMA legislation (see below) all fossils, meteorites and archaeological heritage are protected, any development must be preceded and approved by the South African Heritage Resources Agency (SAHRA).

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	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,	Section 4
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Sections 3, 4
b	A declaration that the person is independent in a form as may be specified by the competent authority	Section 2
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 6
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 12
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 7
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 11
g	An identification of any areas to be avoided, including buffers	Section 13-16
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;	Figure 4
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 17

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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 16
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 13-15
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 16
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 16
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
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Table 1

9. Receiving environment.

a. Project

Barberton Mines wish to make changes to the mining right by adding a portion of the farm property Bramber 314 JU (formerly Bramber East 314 JU). This property also formed part of the initial environment impact assessment process. It is anticipated that the proposed addition will not result in a change of scope to the mining work programme. Therefore, the inclusion of this property into the mining right will allow for the continuation of current and scheduled mining operations.

The Fairview mine is located about 2 km northeast of the town of Barberton (Figure 1) and the area under consideration extends northeast of the Fairview mine (Figure 2).

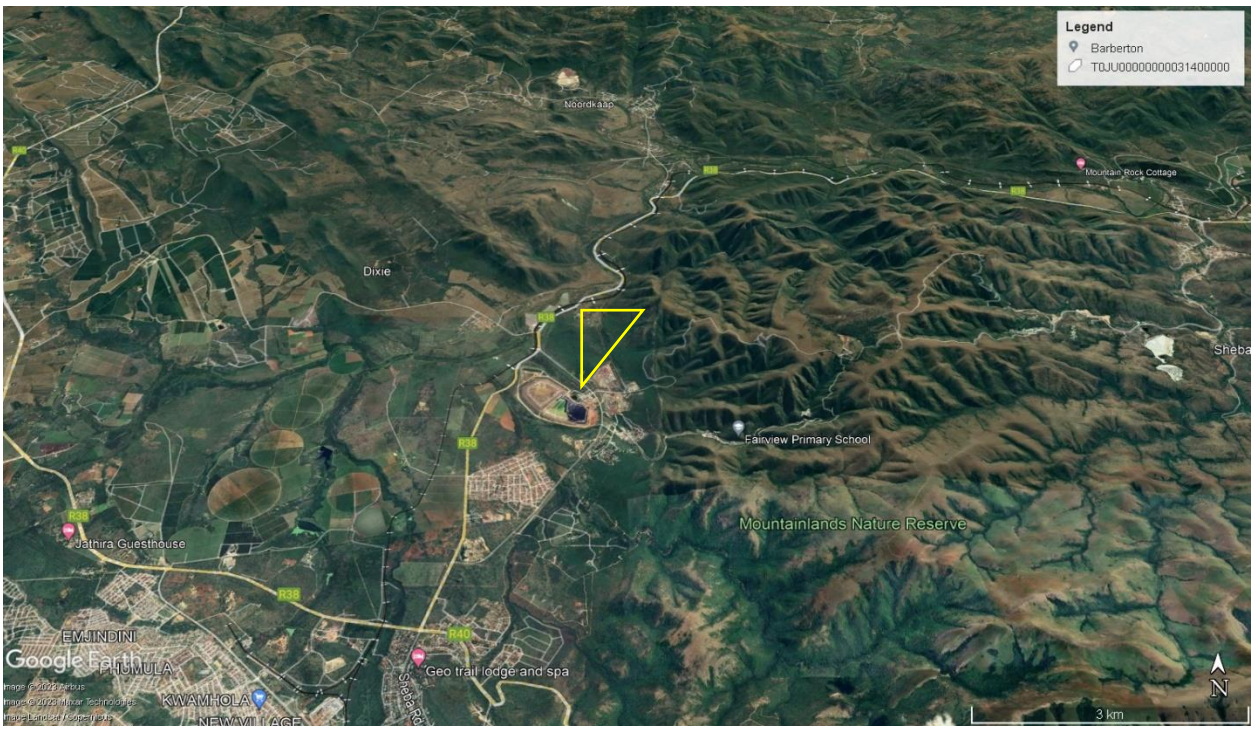

Figure 1: Google Earth Map to show the general area and landmarks. The S102 application area is shown by the yellow outline on Farm Bramber Oos 314 JU. Fairview mine is in the south of the project area.

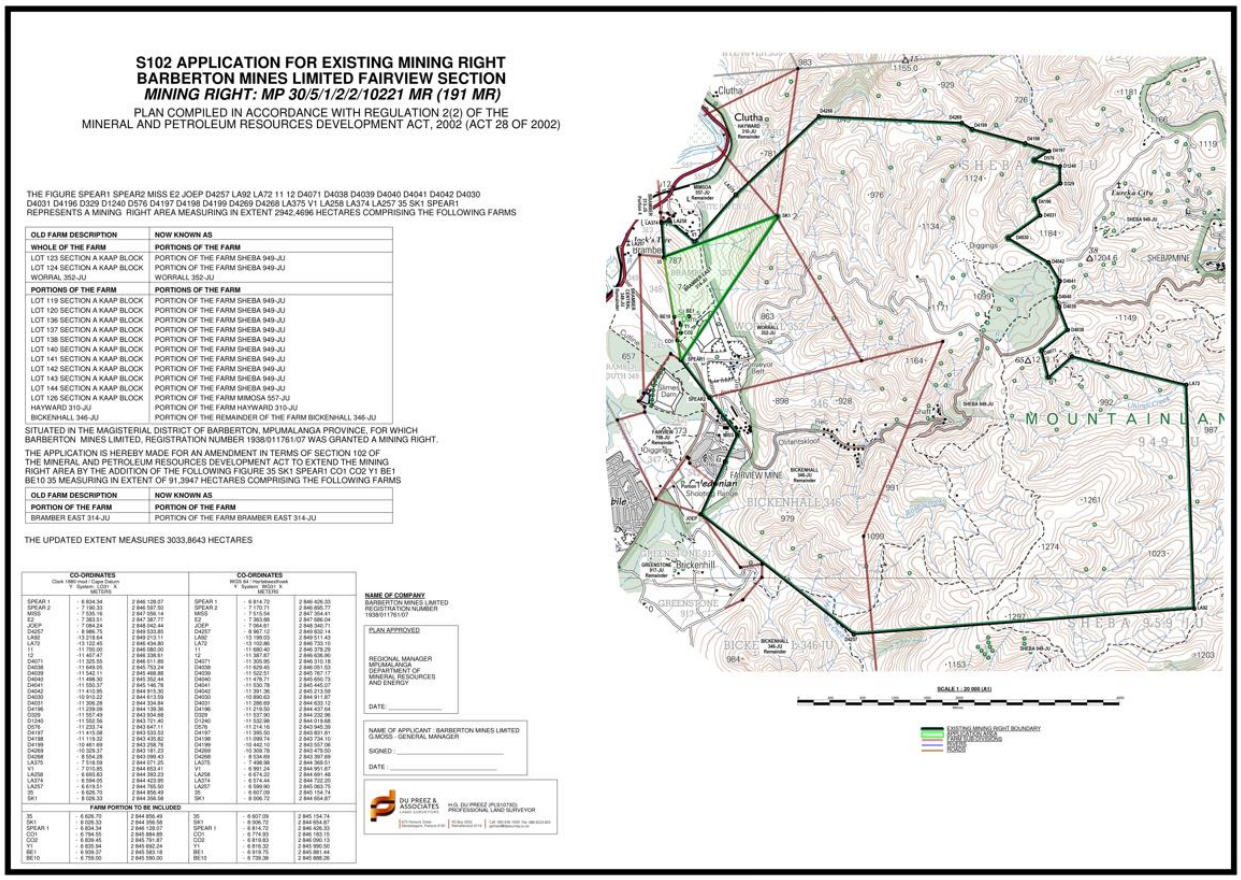

Figure 2: Topographic Map to show the application area details for a portion of Farm Bramber East 314 JU for Fairview Mine. Map supplied by Shango Solutions

b. Geology

The application area lies in the northern part of the Barberton Greenstone Belt (Figure 3). The Barberton Greenstone Belt (BGB) is the largest and best-studied of a number of greenstone belts on the Kaapvaal Craton. Greenstone Belts represent the oldest crustal rocks on the earth so are of major geological interest, as well as the fact they contain economic reserves of heavy minerals such as gold and nickel. The BGB succession is composed of the ca. 3.55-3.22 Ga Swaziland (or Barberton) Supergroup, which is preserved as a folded southwest to northeast-trending belt (Agangi et al., 2018). It has been subdivided into three groups, from the base upwards, the Onverwacht, Fig Tree and Moodies Groups. The basal ca. 3550-3300 Ma Onverwacht Group is dominated by pillow and massive basalt and komatiite, mafic-ultramafic intrusions, felsic volcanic rocks and chert. In contrast, the Fig Tree and Moodies Groups consist of sandstone, shale, chert, banded iron formation and felsic volcanic rocks ranging in age from ca. 3260-3216 Ma

The southwest to northeast-trending Inyoka-Saddleback Fault System separates a northern and a southern terrane of different age and geochemical characteristics (Brandl et al., 2006; Agangi et al., 2018). The Supergroup has undergone multiple deformation events (D1-D4), and has been metamorphosed under conditions of greenschist to amphibolite facies, and the final phase of deformation formed the gold deposits.

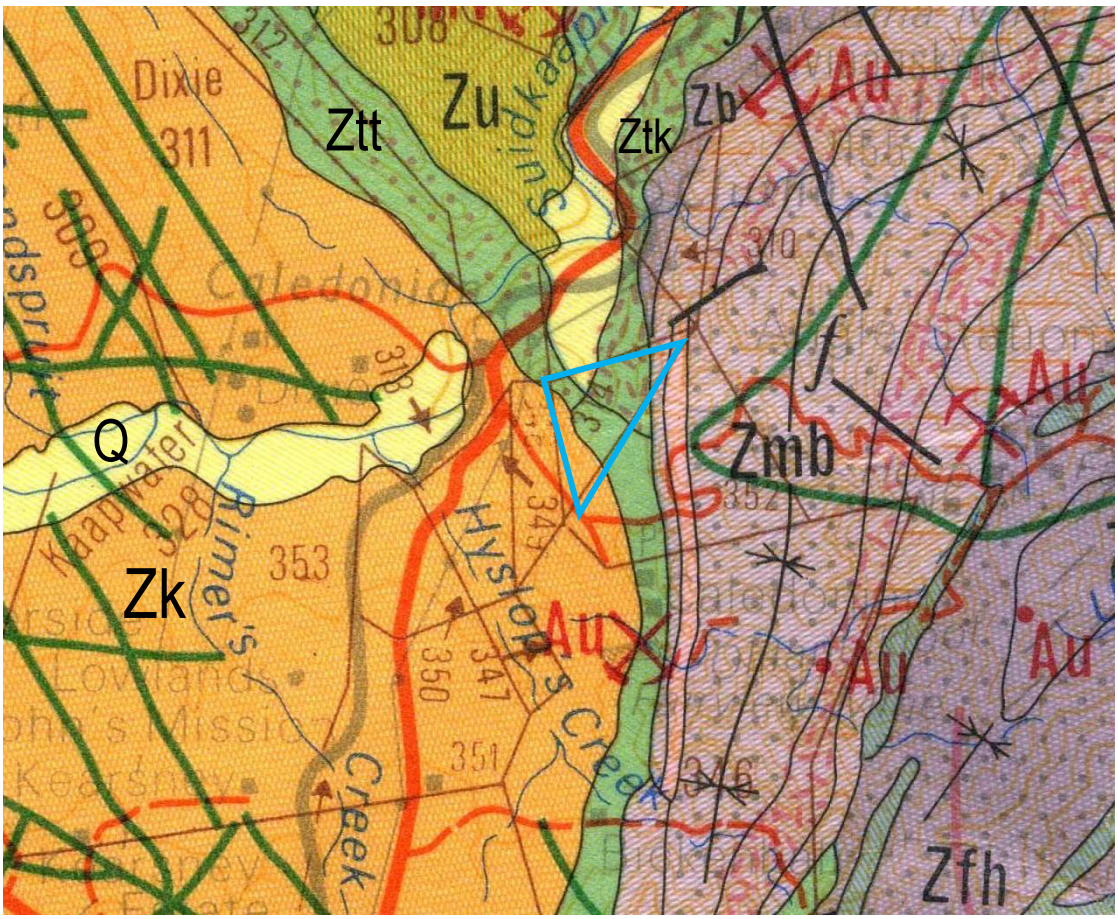

Figure 1: Geological map of the application area around the Fairview Mine. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2530 Pilgrims Rest.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; Robb et al., 2006; van der Westhuizen et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Quaternary ca 1.0 Ma to Present
Zm	Moodies Group, Barberton SG	3 upward-fining cycles:	3220 Ma early life in this group, stromatolites, MISS, etc.
Zmb	Baviaanskop Fm, Moodies Group, Barberton SG	Sandstone, grit, conglomerate, shale, phyllite	Mesoarchaean Ca 3 200 Ma
Zj	Joe's Luck Fm, Moodies Group, Barberton SG	Sandstone, grit, conglomerate, shale, phyllite	Mesoarchaean Ca 3 200 Ma
Zmc	Cluthra Fm, Moodies Group, Barberton SG	Sandstone, grit, conglomerate, shale, phyllite	Mesoarchaean Ca 3 200 Ma
Zf	Fig Tree Group, Barberton SG	Sandstone, grit, conglomerate, shale, phyllite	Palaeoarchaean Ca <3 200Ma
Zfs	Schoongezicht Fm, Fig Tree Group, Barberton SG	Deepwater facies; Coarse volcaniclastic sandstone, conglomerate, breccia, mudstone and shale	3260-3225 Ma
Zb	Belvue Road Fm, Fig Tree Group, Barberton SG	Shale, turbiditic siltstone and greywacke, chert, local volcaniclastic rocks and altered komatiite; black chert at the top	Palaeoarchaean
Zfh	Sheba Fm, Fig Tree Group, Barberton SG	Turbiditic lithic greywacke, shale	Palaeoarchaean
Zz	Zwartkoppies Fm, Geluk Subgroup, Onverwacht Group	Basaltic, komatiitic metavolcanics	Palaeoarchaean
Zgk	Kromberg Fm, Geluk Subgroup, Onverwacht Group	Basaltic, komatiitic metavolcanics	Palaeoarchaean
Zgh	Hoeggenog Fm, Geluk Subgroup, Onverwacht Group	Basaltic, komatiitic metavolcanics	Palaeoarchaean
Ztk	Komati Fm, Tjakastad Subgroup, Onverwacht Group	Basaltic and peridotitic komatiite, theolititic sediments	Palaeoarchaean
Ztt	Komati Fm, Tjakastad Subgroup, Onverwacht Group	Mafic and ultramafic schists	Palaeoarchaean

Felsic volcanic rocks in the Onverwacht Group are mostly preserved in the Theespruit, Sandspruit and Hooggenoeg Formations. The lowermost portion is the Theespruit and Sandspruit Formations, dated at ca. 3552-3521 Ma. They are composed of strongly foliated mafic-ultramafic to felsic volcanic rocks and shallow intrusions metamorphosed at amphibolite facies conditions. These two formations are separated from the overlying mafic ultramafic volcanic rocks of the Komati Formation by the Komati fault (de Ronde and de Wit, 1994; Lana et al., 2010a). The Hooggenoeg Formation, includes felsic volcanic and intrusive rocks, volcaniclastic conglomerates, sandstone and tuffs.

The Fig Tree Group is also known to contain dacitic volcanic and volcaniclastic rocks (tuffs and agglomerates), dated between 3259 Ma and 3225 Ma, although little information on the chemical composition of these rocks is available in the literature (Agangi et al., 2018). These ages overlap at least in part with the intrusions to the north-west of the Barberton Greenstone Belt, such as the 3229-3223 Ma Kaap Valley tonalite.

According to the review by Agangi et al. (2018), the base of the Moodies Group in the vicinity of the Eureka Syncline contains prominent pebble to cobble conglomerate beds intercalated with sandstone. The clasts consist mainly of black chert and felsic igneous clasts. Igneous clasts have variable textures, from porphyritic to granophyric, indicative of a volcanic or shallow intrusive origin. Some clasts contain predominant quartz, K-feldspar and biotite, and accessory zircon, apatite and monazite and their dating clusters into three groups that indicate the presence of shallowly-emplaced K-rich intrusive rocks with ages pre-dating the emplacement of mafic intrusions (mostly <3.2 Ga).

c. Palaeontology

There are two strata in the BGB that have strong evidence of the earliest microbial life forms, namely the deposits of the 3.416 Ga Buck Reef Chert (in the Onverwacht Anticline and Kromberg Syncline, central part) and the sandstones of the 3.22 Ga Moodies Group (see recent review by Homan (2019)). These strata have a wealth of remarkably preserved microbial mats and microfossils, consistent lateral exposure for several tens of kilometres and thick stratigraphy. Based on its universal and outstanding geological and palaeobiological value the Barberton-Makhonjwa Mountains were inscribed in the UNESCO World Heritage Site register in 2018. These fossils will ultimately help to protect these exceptional outcrops for future studies of Earth's early evolution.

Such microfossils would be impossible to recognise in the field as the structures are very small and cryptic. Thin sections and a petrographic microscope are required. These rocks, however, are not considered to be fossiliferous by SAHRA (Groenewald et al., 2014).

10. Consideration of related/significant aspect management plans in the area.

Fossils are an irreplaceable part of our heritage. Some fossils are common, and some are extremely rare. The relative importance of the fossils is largely according to the specialists' own field of expertise and interest, but all fossils are treated as important under SAHRA legislation. Nonetheless, factors such as their rarity (or not), the quality of their preservation,

the completeness of the original organism, and its context, i.e., it is important to know where the fossil comes from and what other fossils were associated with it - the whole fossil assemblage. Fossils that are very common or fragmented or poorly preserved or transported have limited scientific value.

Fossils are dead organisms so no longer interacting with other organisms; therefore, the removal of some fossils will not impact on the other fossils or on the environment.

Mostly the presence of fossils in an environment is unknown until they are discovered, by excavations, trenching, mining or natural or human induced erosion. There is some value in leaving fossils undisturbed in the ground until someone wants to study them. In contrast, developments, construction of roads and infrastructure and mining have revealed important fossil sites that would otherwise have remained unknown. In summary, the disturbance of fossils can have a positive impact if they are correctly extracted from the ground and made available for future study – mitigation.

11. **Sensitivity mapping**.

Figure 2: SAHRIS palaeosensitivity map for the site for the proposed S102 application on a portion of Farm Bramber East 314 JU for Fairview Mine shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

After consultation of the SAHRIS palaeosensitivity map the sensitivity of the site can be summarised as having low sensitivity (blue) in Figure 4 for the Onverwacht Group rocks and moderately sensitive for the Quaternary sands. The Kaap Valley Pluton has zero

palaeosensitivity as it is a volcanic rock so is shown as grey. Granites do not preserve fossils and these granites pre-date the evolution of any life forms (Plumstead, 1969).

It should be noted that the SAHRIS map has been developed from the provincial palaeotechnical reports commissioned by SAHRA. These were written by experienced field palaeontologists so are more accurate than the DFFE screening report. The relevant report for this project is by Groenewald et al. (2014).

12. Impact assessment

Shango Solutions Method of Assessing Impacts

The impact assessment method is guided by the requirements of the NEMA EIA Regulations (2014). The broad approach to the significance rating method is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

Determination of Environmental Risk

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the nature (N), extent (E), duration (D), magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this method the consequence of the impact is represented by:

$$C = \frac{(E+D+M+R)}{4} \times N$$

Each individual aspect in the determination of the consequence represented by a rating scale as defined in Table 3a.

Table 3a: Criteria for determining impact consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary)
	3	Local (i.e. the area within 5 km of the site)
	4	Regional (i.e. extends between 5 and 50 km from the site)
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)

Aspect	Score	Definition
	2	Short term (1-5 years)
	3	Medium term (6-15 years)
	4	Long term (the impact will cease after the operational life span of the project)
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction)
Magnitude/ Intensity	1	1 Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way)
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease)
	5	Very high/do not know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease)
Reversibility	1	Impact is reversible without any time and cost
	2	Impact is reversible without incurring significant time and cost
	3	Impact is reversible only by incurring significant time and cost
	4	Impact is reversible only by incurring prohibitively high time and cost
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 3b.

Table 3b: Probability Scoring

Probability	1	1 Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%)
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%)
	3	Medium probability (the impact may occur; >50% and <75%)
	4	High probability (it is most likely that the impact will occur- > 75% probability)
	5	Definite (the impact will occur)

The result is a qualitative representation of relative ER associated with the impact (Table 3c). ER is therefore calculated as follows:

ER= C x P

Table 3c: Determination of environmental risk.

Consequence						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 3d.

Table 3d: Significance classes

Environmental Risk Score	
Value	Description
<9	Low (i.e. where this impact is unlikely to be a significant environmental risk)
≥9 and <17	Medium (i.e. where the impact could have a significant environmental risk)
≥ 17	High (i.e. where the impact will have a significant environmental risk)

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation

In accordance with Appendix 1 of the NEMA 2014 EIA Regulations (GN R.982, as amended), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts
- The degree to which the impact may cause irreplaceable loss of resources

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/ mitigation impacts are implemented (Table 3e).

Table 3e: Criteria for determining prioritisation.

Public response (PR)	Low (1)	Issue not raised in public response
	Medium (2)	Issue has received a meaningful and justifiable public response
	High (3)	Issue has received an intense meaningful and justifiable public response

Cumulative impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change
	High (3)	Considering the potential incremental, interactive, sequential and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions)

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 5.

The impact priority is therefore determined as follows:

Priority = PR + CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Table 3f).

Table 3f: Determination of prioritisation factor.

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance (Table 3g).

Table 3g: Final environmental significance rating.

Environmental Significance Rating	
Value	Description
< -10	Low Negative (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ -10 and < -20	Medium Negative (i.e. where the impact could influence the decision to develop in the area)
≥ -20	High Negative (i.e. where the impact must have an influence on the decision process to develop in the area)
< 10	Low Positive (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ 10 and < 20	Medium Positive (i.e. where the impact could influence the decision to develop in the area)
≥ 20	High Positive (i.e. where the impact must have an influence on the decision process to develop in the area)

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

Table 3h: Summary for the Palaeontological impact:

Project	Fairview Mine – Bramber Oos 314 JU	
Phase	CONSTRUCTION	
Pre / post-mitigation	Pre-mitigation	Post-Mitigation
Nature	-1	+1
Extent	1	1
Duration	1	1
Magnitude	2	1
Reversibility	2	1
Consequence C=(E+D+M+R)/4 x N	-1.5	+1
Probability	1	1
Environmental Risk ER = C x P	-1.5 Low	1 Low
Significance	1	1
Prioritisation		
Public Response (PR)	1	1
Cumulative Impact (CI)	1	1
Irreplaceable loss (LR)	2	1
Priority = PR + CI + LR	4 Low	3 Low
Prioritisation Factor	1	1
Environmental Significance Rating	<-10 Low negative	<10 Low positive

Note: **Mitigation** for palaeontology means the removal of important fossils, or a representative sample of fossils if abundant (with a relevant SAHRA permit). This can be done at the site visit phase (planning)or during the early construction phase by the ECO.

Cumulative Impacts
For the purposes of this report, cumulative impacts are defined as 'direct and indirect impacts that act together with existing or future potential impacts of other activities or proposed activities in the area / region that affect the same resources and / or receptors'.
For the most part, cumulative effects or aspects thereof are too uncertain to be quantifiable, due mainly to a lack of data availability and accuracy. This is particularly true of cumulative effects arising from potential or future projects, the design or details of which may not be finalised or available and the direct and indirect impacts of which have not yet been assessed.

For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities.

Activities Considered
Activities that potentially have cumulative impacts with the proposed Fairview Mine S102 Application on Farm Bramber Oos 314 JU and which are considered in the cumulative impact assessment are listed below:

- The loss of fossils in this site is insignificant and has no impact on other sites.

Note that past and present projects, activities and stressors should have been largely considered in the baseline and thus the impact assessment in 12.

Cumulative Impact Analysis
There will be no cumulative impact for the palaeontology because each site is independent of any other site.

13. Environmental Management Programme.

There are three steps for the management plan listed here

a. Palaeontologist to determine the likelihood of fossils occurring on site (Sections 11 and 12):
    a. High probability – site visit verification required
    b. Possible but unknown – fossil chance find protocol (Section 13b)
    c. No chance of fossils – no management required

b. If possible but cannot be determined until excavations commence then the Chance find protocol must be followed
c. If no fossils are present then the project can proceed. No management or monitory required.

13b Fossil Chance Find Protocol for Palaeontology – to commence once the excavations / drilling / mining activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining 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 (plants, insects, bone or coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones. This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

14. Action plan.

Table 4: Action plan for Palaeontology

Phase	Management Action	Timeframe	Responsibility (frequency)	Reporting
Planning	Desktop PIA Site visit and removal of fossils (mitigation)	Before construction During site visit if required	Once Only if required	SAHRA Palaeontologist
Construction	Fossil Chance find protocol	When new ground is opened	When new ground is opened	Applicant and ECO
Operation	None	n/a	n/a	n/a
De-commissioning	None	n/a	n/a	n/a

15. **Monitoring plan**.

Refer to the fossil chance find protocol (section 13b).
Only required if fossils are found by the applicant or ECO when excavations commence on new ground. This only applies to the project footprint.
If there are no fossils then no monitoring is required.

16. **Conclusion**.

Based on the geological maps of the area and the SAHRIS and other databases consulted, and quantified using the Impact Assessment Method (Section 12), there is no chance/low chance/moderate chance of finding fossils in the project footprint.

There are no no-go areas because the application area has very low palaeosensitivity.

There are no preferred sites because the whole application area has very low palaeosensitivity.

There is no cumulative impact because each site is unique as far as the fossil flora and fauna occurring there and has no impact on adjacent sites. In addition, this project has very low palaeosensitivity.

As far the palaeontology is concerned, there will be a very low to zero impact on the fossil heritage so the S102 application should be authorised.

17. **Assumptions, uncertainties and gaps in knowledge**.

The study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

- It is assumed that the geological mapping is accurate and so it is possible to predict what fossils are likely to occur in the strata, or no fossils are likely to occur
- The SAHRIS map is based on the geology and recommendations listed in the SAHRA Palaeotechnical Reports

- Limitations
- The site visit walk down only reveals what rocks (and fossils) are present on the land surface. It is not possible to see what occurs below the land surface unless there is an existing trench or excavation.
- The Geological map and SAHRIS map only indicate the likelihood of fossils occurring at any site.

18. **References**.

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