

Waterberg JV Resources (Pty) Ltd. Waterberg Project

Blouberg Local Municipality, Capricorn District Municipality, Limpopo Province.

Farm: Rosamund 357-LR, Disseldorp 369-LR, Millstream 358-LR, Ketting 368-LR, Portion 1 Goedetrouw 366-LR, Goedetrouw 366-LR, Early Dawn 361-JR, Old Langsine 360-LR, Langbryde 324-LR, and Lomondside 323-LR.

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 942 0110 x 1057

Palaeontological Impact Assessment: Desktop Study

Commissioned by: Bateleur Environmental & Monitoring Services

P.O. Box 70706,

Die Wilgers,

0041

082 338 6607

Ref: DMR LP 30/5/1/2/2/2/10161 MR

2019/07/31



B. Executive summary

Outline of the development project: Bateleur Environmental & Monitoring Services has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Desktop Study of the suitability of the proposed Waterberg JV Resources (Pty) Ltd. on the Farms Rosamund 357-LR, Disseldorp 369-LR, Millstream 358-LR, Ketting 368-LR, Portion 1 of Goedetrouw 366-LR, Goedetrouw 366-LR, Early Dawn 361-LR, Old Langsine 360-LR, Langbryde 324-LR, and Lomondside 323-LR, Capricorn District Municipality, Blouberg Local Municipality within the Limpopo Province.

The applicant, Waterberg JV Resources (Pty) Ltd. Plans to mine for platinum in the area.

The Project includes one Alternative (Figure 1):

Alternative 1: An area outlined in red following the farm borders. The settlement of Bochum is to the east and the town of Polokwane is to the southeast. The size of the site is approximately 22 204 ha in size.

Legal requirements:-

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

A Palaeontological Impact Assessment is generally warranted where rock units of **LOW to VERY HIGH** palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):

(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.

This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).

Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding

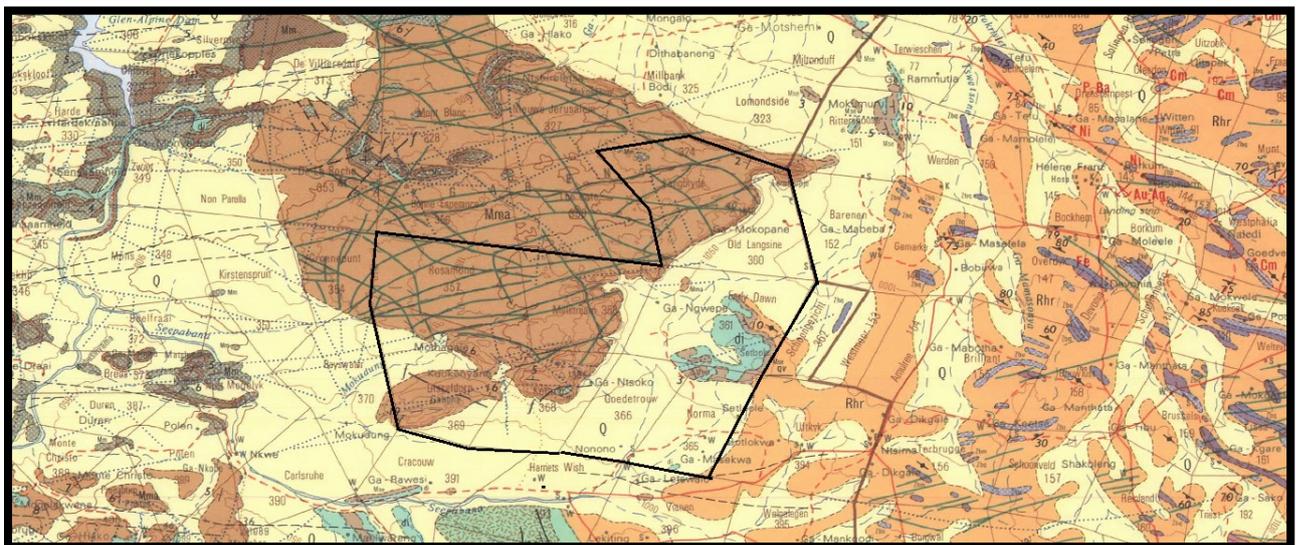
50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:

The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 1:250 000, 2328 Pietersburg (Brandl 1985).

Figure 3: The geology of the development area.



Legend to map and short explanation.

- Q – Soil, sand, alluvium, calcrete, scree (yellow). Quaternary.
- di – Diabase (green). Vaalian.
- Mma – Medium-grained, yellowish, laminated sandstone (brown). Makgabeng Formation, Waterberg Group. Mokolian.
- Rhr – Hout River Gneiss. Randian.
- – (black) Lineament (Landsat, aeromagnetic).
- - Concealed geological boundary.
- └12 – Strike and dip of bed.
- – Proposed Mining (in black on figure).

Summary of findings (1d): The Desktop Study was undertaken in July 2019 in the winter in mild and dry conditions and the following is reported. As this is a desktop study the season has no influence on the outcome.

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually unfossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between

the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996).

The Waterberg Group of rocks today occurs in several separate regions: in the Limpopo and Mpumalanga Provinces. These separate patches probably originally formed a single sheet of sedimentary rocks that since became fragmented as a result of erosion. A deep red iron oxide is responsible for the colouration. As the rocks are chemically resistant and very hard, they produce spectacular cliffs and mountainous topography (McCarthy and Rubidge 2005). The Waterberg Group (Kent 1980) is known for its reddish sandstone with conglomerates present between Pretoria and Middelburg, older than the coal and younger than the Magaliesberg Quartzite Formation. Trace fossils are found in the Waterberg Group. Snyman (1996) places the age as 1 800 Ma till 1 700 Ma (Mokolian). A threefold subdivision is recognised, the Nylstroom, Matlabas and Kransberg Subgroups. It overlies the Loskop Formation.

Palaeontology - Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of sedimentary strata the palaeontological sensitivity can generally be **LOW to VERY HIGH**, and here locally **MODERATE** for the Quaternary age rocks and **LOW** for the Makgabeng Formation, Waterberg Group (SG 2.2 SAHRA APMHOB, 2012).

The Quaternary Formation may contain fossils. A wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size, also present in the Makgabeng Formation (Groenewald and Groenewald 2014).

Recommendation:

The potential impact of the development on fossil heritage is **MODERATE and LOW**, therefore a field survey or further mitigation or conservation measures are necessary if fossils are found (according to SAHRA protocol). A Phase 1: Field Study may be necessary to determine where the fossiliferous outcrops are and a Phase 2 PIA and or mitigation is only recommended if fossils are found during construction.

The development will benefit the community, the economy, industries and businesses. Only one Alternative is proposed. The mine infrastructure will be located on the farms with Quaternary sediments.

The Project includes one Alternative (Figure 1):

Alternative 1: An area outlined in red following the farm borders. The settlement of Bochum is to the east and the town of Polokwane is to the southeast. The size of the site is approximately 22 204 ha in size.

Concerns/threats (**1g,1ni,1nii,1o,1p**) to be added to the EMPr:

1. Threats are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic, mining, prospecting, and human disturbance.
2. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden as a site visit may have missed a fossiliferous outcrop. An appropriate Protocol and Management plan is attached for the Environmental Control Officer (Appendix 2).

The recommendations are:

1. Mitigation may be needed (Appendix 2) if fossils are found.
2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or - herself with the formation present and its fossils and obtain training pre-construction (one day).
3. The development may go ahead.
4. The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities. For a chance fossil find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist (pre-construction training of ECO) and the ECO together with the mine geologist must visit and survey site after blasting and excavating, alternatively visit the site once a month.

Stakeholders: Developer – Waterberg JV Resources (Pty) Ltd., Postnet Suite 81, Private Bag X12, Roosevelt Park, 2129.

Environmental – Bateleur Environmental & Monitoring Services, P.O. Box 70706, Die Wilgers, 0041.
Tel. 082 338 6607.

Landowner – Several Private and Government.

C. Table of Contents

A. Title page	1
B. Executive Summary	2
C. Table of Contents	5
D. Background Information on the project	5
E. Description of the Property or Affected Environment	7
F. Description of the Geological Setting	8
G. Background to Palaeontology of the area	10
H. Description of the Methodology	12
I. Description of significant fossil occurrences	14
J. Recommendation	14
K. Conclusions	15
L. Bibliography	15
Declaration	16
Appendix 1: Examples of Quaternary Formation fossils	17
Appendix 2: Protocol for Chance Finds and Management Plan	18
Appendix 3: Table	18

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R326 of 7 April 2017) of the Environmental Impact Assessment Regulations (see Appendix 3). It is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, Guidelines 2012.

Outline of development

This report discusses and aims to provide the applicant with information regarding the location of palaeontological material that will be impacted by the development. In the construction phase, it may be

necessary for the applicant to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA) if a fossil is unearthed.

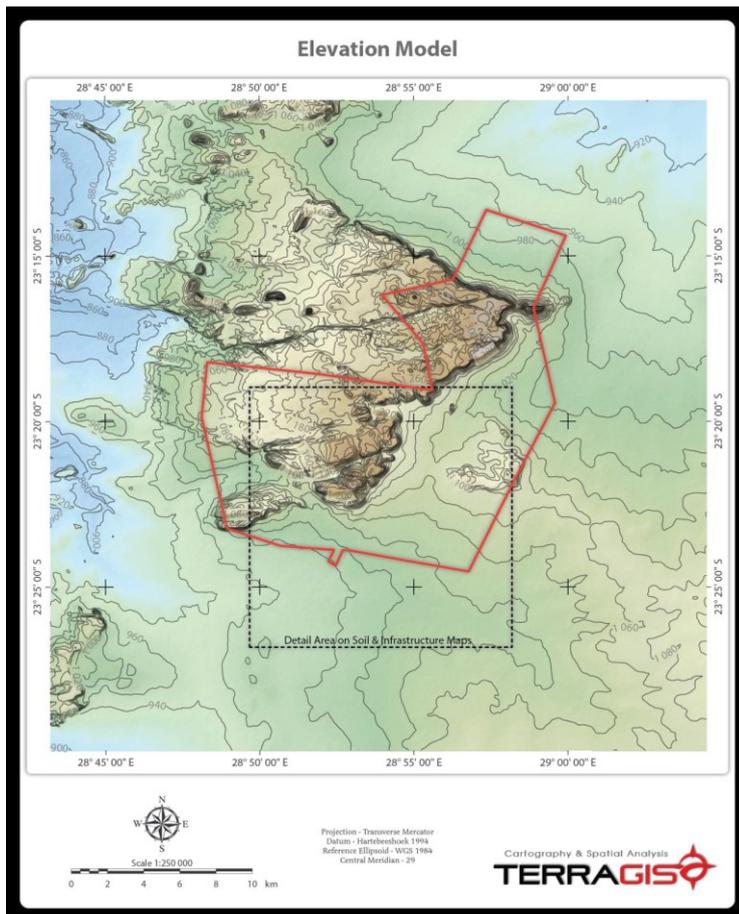
The applicant, Waterberg JV Resources (Pty) Ltd. Projects proposes to undertake underground mining for platinum. This will commence with the Tailings Storage Facility on the Farm Ketting and the Farm Goedetrouw will house the Metallurgical Plant. There will be two mining complexes namely, North and South. Mining will take place to a depth of 1 200 m below surface. Once the Southern complex has been mined out it is planned that the mine production will continue from the Northern complex. The Farm Disseldorp will also be used for some of the infrastructure.

Local benefits of the proposed development include benefits to the local economy through possible job creation, skills development and local supplier procurement during the construction phase as well as during the operational phase of the development.

Related infrastructure:

1. Tailings Storage Facility (TSF),
2. Northern and Southern Complexes,
3. Overland conveyor system,
4. A Process Plant,
5. Pollution Control Dams (PCD),
6. Sewage Treatment Plant (STP),
7. Access road,
8. Waste handling facility,
9. Powerlines and substations,
10. A helipad,
11. A shared services complex, and
12. Clean bulk water pipelines.

Figure 1: Development location (Bateleur)



The Project includes one Alternative (Figure 1):

Alternative 1: An area outlined in red following the farm borders. The settlement of Bochum is to the east and the town of Polokwane is to the southeast. The size of the site is approximately 22 204 ha in size.

Rezoning/ and or subdivision of land: From Agriculture/Residential to Mining.

Name of developer and consultant: Waterberg JV Resources (Pty) Ltd. and Bateleur Environmental & Monitoring Services.

Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.

Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. She is currently employed by Ditsong: National Museum of Natural History as Curator of the fossil invertebrate, plant, dinosaur, Therapsid, amphibia and reptile collections. For the past 13 years she carried out field work in the Eastern Cape, Western Cape, Northern Cape, North West, Free State, Gauteng, Limpopo, Mpumalanga and Kwazulu Natal Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 25 years.

Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA.

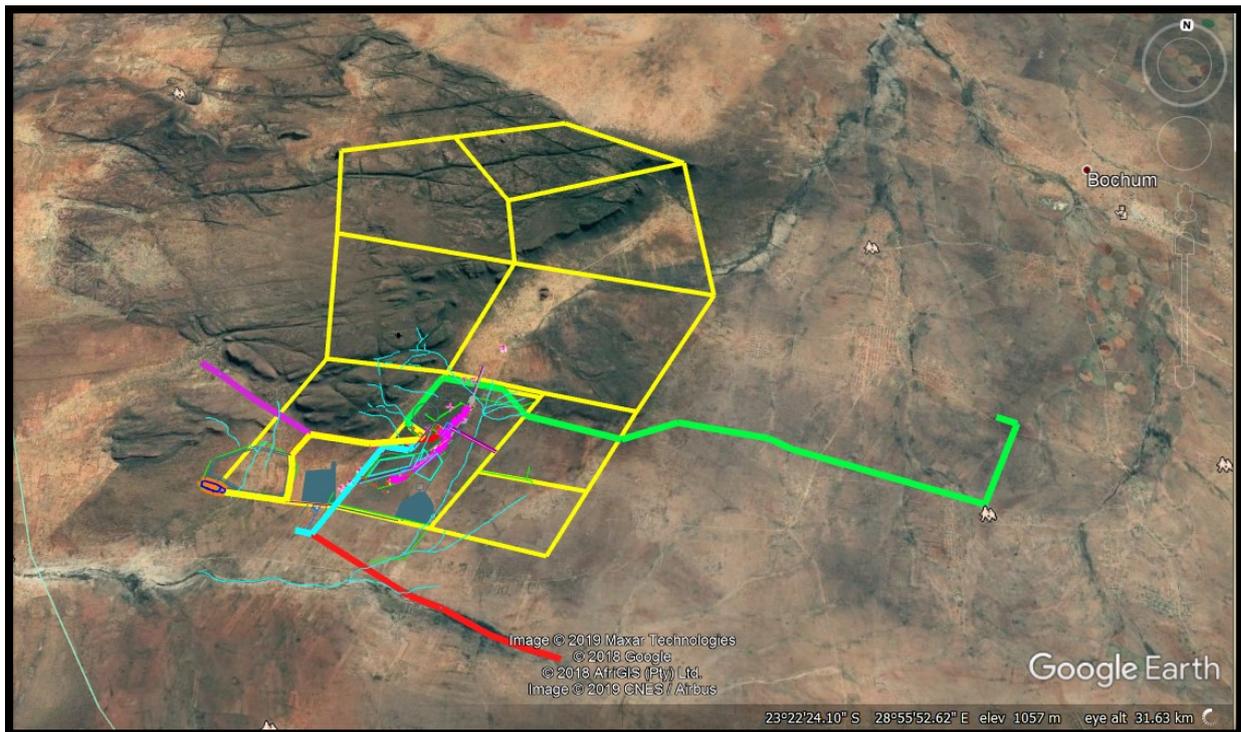
E. Description of property or affected environment

Location and depth:

The proposed Waterberg JV Resources (Pty) Ltd. will be situated on the Farms Rosamund 357-LR, Disseldorp 369-LR, Millstream 358-LR, Ketting 368-LR, Portion 1 of Goedetrouw 366-LR, Goedetrouw 366-LR, Early Dawn 361-LR, Old Langsine 360-LR, Langbryde 324-LR, and Lomondside 323-LR, Capricorn District Municipality, Blouberg Local Municipality within the Limpopo Province.

Depth is determined by the infrastructure to be developed and the thickness of the formation in the development area. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops.

Figure 2: Location map of proposed infrastructure (Bateleur).



The Project includes one Alternative (Figure 1):

Alternative 1: An area outlined in red following the farm borders. The settlement of Bochum is to the east and the town of Polokwane is to the southeast. The size of the site is approximately 22 204 ha in size.

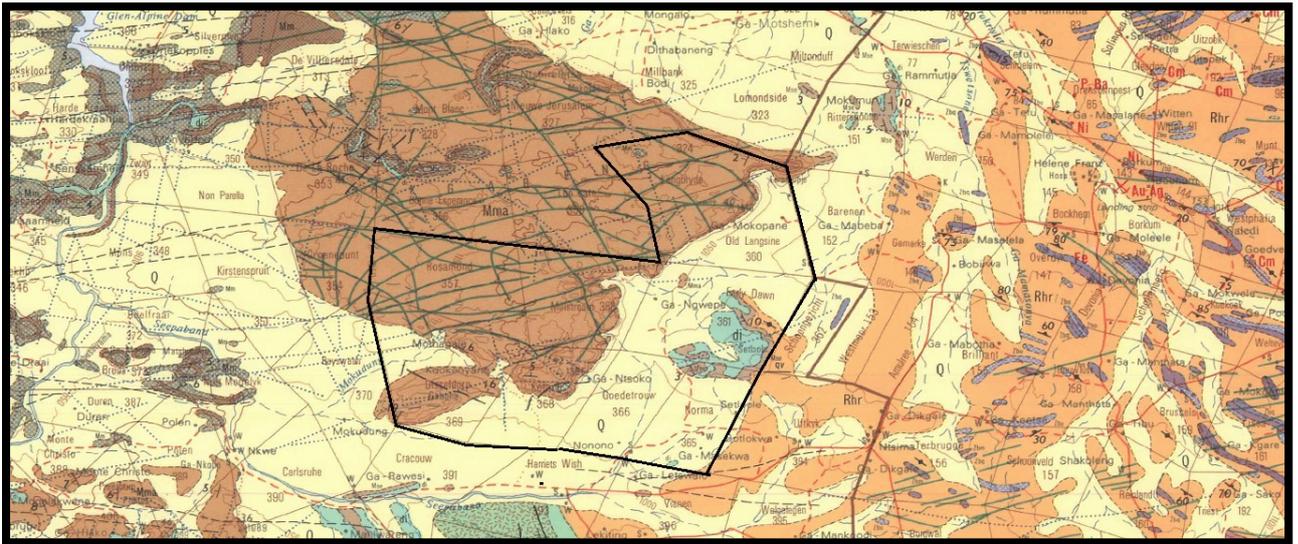
The site is underlain by the Quaternary age rocks and the Makgabeng Formation, Waterberg Group.

F. Description of the Geological Setting

Description of the rock units:

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually unfossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996).

Figure 3: Excerpt of 1:250 000 Geological Map 2328 Pietersburg (Brandl 1985).



Legend to map and short explanation.

Q – Soil, sand, alluvium, calcrete, scree (yellow). Quaternary.

di – Diabase (green). Vaalian.

Mma – Medium-grained, yellowish, laminated sandstone (brown). Makgabeng Formation, Waterberg Group. Mokolian.

Rhr – Hout River Gneiss. Randian.

..... – (black) Lineament (Landsat, aeromagnetic).

----- Concealed geological boundary.

⊥12 – Strike and dip of bed.

□ – Proposed mining area (in black on figure).

Mining Activities:

Au – Gold

Ag - Silver

Ba – Barytes

Cm – Corundum

Fe –Iron

Ni- Nickel

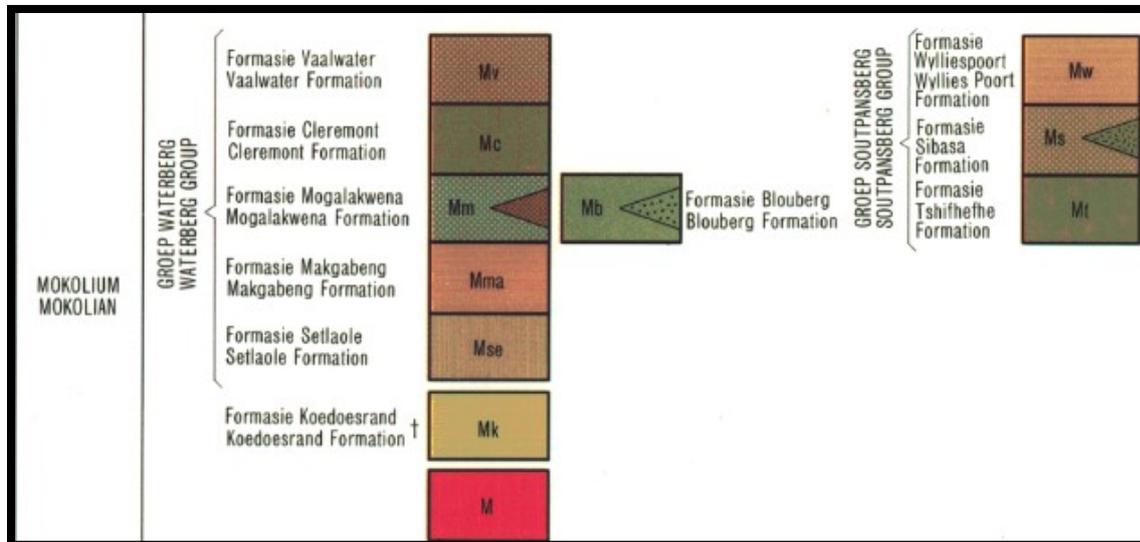
P - Phosphate

The Waterberg Group of rocks today occurs in several separate regions: in the Limpopo and Mpumalanga Provinces, an area spanning 20 000 km². These separate patches probably originally formed a single sheet of sedimentary rocks that since became fragmented as a result of erosion. A deep red iron oxide is responsible for the colouration. As the rocks are chemically resistant and very hard, they produce spectacular cliffs and mountainous topography (McCarthy and Rubidge 2005). The Waterberg Group (Kent 1980) is known for its reddish sandstone with conglomerates present between Pretoria and Middelburg, older than the coal and younger than the Magaliesberg Quartzite Formation. In the Cullinan-Middelburg base only one formation has been recognised, the unconformable Wilgerivier Formation. A threefold subdivision is recognised in the main basin, the Nylstroom, Matlabas and Kransberg Subgroups. It overlies the Loskop Formation. The Wilgerivier Formation overlies the Pretoria Group of the Transvaal Supergroup, the Selonsrivier Formation and the Loskop Formation. It is often covered with Karoo sediments. Sandstone, grit, conglomerate and shale are present. It is 2000 m in thickness. The conglomerate layer is often at the base (Visser 1989). Trace fossils are found in the Waterberg Group. Snyman (1996) places the age as 1 800 Ma till 1 700 Ma (Mokolian).

The Swaershoek and Alma Formations are in the Nylstroom Subgroup; Skilpadkop, Aasvoëlkop, Setlaole, and Makgabeng Formations in the Matlabas Subgroup; and Sandriviersberg, Mogalakwena, Cleremont and Vaalwater Formations in the Kransberg Subgroup. The Makgabeng Formation forms part of the Makgabeng

Plateau with a thickness of 300 – 600 m up to 1000 m. Also part of the Waterberg Group are the Koedoesrand Formation and the Blouberg Formation (Visser 1989).

Figure 4: Lithostratigraphy (Brandl 1985).



The project includes one Alternative (Figure 1)

Alternative 1: An area outlined in red following the farm borders. The settlement of Bochum is to the east and the town of Polokwane is to the southeast. The size of the site is approximately 22 204 ha in size.

The mine infrastructure will be located on the farms with Quaternary sediments. There is evidence of mining past and present. The platinum is probably present in the underlying Bushveld Complex.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

The Cenozoic Era, in which we are presently living, is popularly known as the 'Age of the Mammals'. Its fossils are preserved on the river gravel terraces (Cornelia), cave systems (Makapan), coastal plains (Langebaanweg), and basins. The Cenozoic Era of South Africa has been subdivided into six African Land Mammal Ages, namely, Recent, Florisian, Cornelian, Makapanian, Langebaanian, and Namibian (MacRae 1999).

Significant fossil finds in the Free State are recorded from Cenozoic aged superficial deposits at specific localities such as Florisbad, Cornelia and others. The fossils recorded include bones and teeth of mammals, reptiles, fish, freshwater molluscs, petrified wood, trace fossils, rhizoliths and diatom floras (Groenewald and Groenewald 2014).

A very wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow

water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere. Stromatolites may also be present in the Makgabeng Formation (Groenewald and Groenewald 2014).

The Quaternary deposits are covered by the Heritage Impact Assessment and if fossils are present these should be studied by an archaeozoologist as they do faunal lists through identification of individual skeletal elements. Groenewald and Groenewald 2014 described these as alluvial deposits associated with recent water courses of main rivers and streams. These sediments are presently not well studied and records of fossil occurrences are mainly associated with archaeological reports. The floodplains are protected by the 1:100 and 1:50 year flood lines that cannot be intruded during construction, except for roads, services and parking areas.

Taung is north of Kimberley closer to Vryburg and is known for the Taung child or *Australopithecus africanus*. Another well-known site is that of Florisbad near Bloemfontein which yielded archaic *Homo sapiens*. Early in the Palaeocene, mammals of all types became abundant and at the beginning of the Miocene the primates became abundant and approximately eight million years ago the first hominin lineage is seen (McCarthy and Rubidge 2005).

Table 1: Taken from The Palaeotechnical Report (Groenewald and Groenewald 2014).
Quaternary

CAENOZOIC SUPERFICIAL DEPOSITS (Q) Quaternary (1.6 to 0 Ma)				Qs: Qw; Q; Q40; T3; Qc; Qf; Tc; Q-c; T; @mo2; Te7; Q27; Q3	Aeolian sand, alluvium, colluvium, spring tufa (calcareous) and sinter (siliceous), lake deposits, peats, pedocretes or duricrusts (calcrete, ferricrete), soils, river terrace gravel	Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms and other microfossil groups, trace fossils (e.g. calcitrated termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens Fossil leaves and palynomorphs within calc tufa	Lake Fundudzi is one of few inland lakes in southern Africa- still to be paleontologically investigated Key palynological studies on peats from Wonderkrater Spring Mound – important information on paleoclimate and vegetation change over past 20 000 years
--	--	--	--	---	--	--	---

Waterberg.

WATERBERG	Ernsberg (kr1)	Viehester (Mrc; vw) Clermont (Mrc; c)	Sandriviersberg; Mogalakwena (Mmm)		Continental "red beds" - predominantly braided stream deposits (sandstones, conglomerates with minor mudrocks), Also beach, tidal flat, lacustrine, aeolian and possible marine shelf sediments	Earliest known terrestrial cyanobacterial mats recorded from playa lake deposits of the Makgabeng fm (Waterberg Group) (1.8 Ga) on the Makgabeng Plateau, Waterberg	Early Proterozoic "red beds" provide evidence for the development of an oxygenated atmosphere after c. 20a
	Mettabas	Aervo (kop; Mmm; w) Makgabeng (mk) Skilpedoop (sk) Setlaole (Msa)			Musekwa Member also referred to as Musekwa Formation, 400m thick volcanic assemblage		Gientig Formation was previously included within the uppermost Pretoria Group (1.1 million mag) but is now regarded as a proto-Waterberg / Soutpansberg unit.
	Nylstroom	Alma (Ma; w) Swershoek (Mwoc; sw)				Early to Mid Proterozoic (Makollian)	
		Gientig (Vg1)				c. 2 to 1.7 Ga	
SOUTHPANBERG		Steyt (Ms) Sibax (s) Tshifhehe (Mrc; t) MF	Musekwa (mw) lavas				
		Wyllies Poort (Mwoc; wy) Ntshalele (Mrc; nt) Mabalgwa (Mmrc; ma) Siboung (Mbl)					

Legend:

Green – Moderate.

Blue – Low.

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of sedimentary strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally MODERATE for the Quaternary age rocks, and LOW for the Makgabeng Formation (Mma).

Rock Unit	Significance/vulnerability	Recommended Action
Q	Moderate	Desktop study is required.
Mma	Low	No palaeontological studies are required, however a protocol for finds is required.

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA).

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).

Impact: **MODERATE** for the Quaternary and **LOW** for the Makgabeng Formation. There are significant fossil resources that may be impacted by the development.

H. Description of the Methodology (1e)

The palaeontological impact assessment desktop study was undertaken in July 2019. A field assessment will include a walkthrough of the affected portion and photographs (in 20 mega pixels) taken of the site with a digital Canon camera (PowerShot SX620HS). It may be necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. A literature survey is included and the study relied on literature, geological maps, google.maps, and google.earth images.

SAHRA Document 7/6/9/2/1 only requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate on outcrops which may be recorded on a GPS. Isolated occurrences of rocks usually do not constitute an outcrop. Fossils can occur in dongas, as nodules, in fresh rock exposures, and in riverbeds. Finding fossils require the experience and technical knowledge of the professional palaeontologist, but that does not mean that an amateur can't find fossils. The geology of the region is used to predict what type of fossil and zone will be found in any particular region. An archaeozoologist can be called upon to assess more recent quaternary and tertiary deposits.

Assumptions and Limitations (1i):-

The accuracy and reliability of the report may be limited by the following constraints:

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. Inaccessibility of site.
7. Insufficient data from developer and exact lay-out plan for all structures (for this report all required data/information was provided).

A Phase 1 Palaeontological Impact Assessment: Field Study will include:

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.
5. Background to palaeontology of the area.
6. Heritage rating.
7. Stating of significance (Heritage Value).

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes -

Act No. 25 of 1999. National Heritage Resources Act, 1999.

The National Estate as: 3 (2) (f) archaeological and palaeontological sites, (i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,

Heritage assessment criteria and grading used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;

(b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and

(c) Grade 3: Other heritage resources worthy of conservation.

SAHRA is responsible for the identification and management of Grade 1 heritage resources.

Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.

Local authorities identify and manage Grade 3 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.

Archaeology, palaeontology and meteorites: Section 35.

(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (e. g. during bedrock excavations), this must be safeguarded, where feasible *in situ*, and reported to a palaeontologist or to the

Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (e. g. Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences (1f)

A very wide range of possible Quaternary fossil remains occur, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, activities, the sealing-in or destruction of fossils by development, vehicle traffic, mining, prospecting, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1j,1l)

a. There is no objection (see Recommendation B) to the development, but it may be necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to identify fossiliferous outcrops as the palaeontological sensitivity is **MODERATE** and a Phase 2 Palaeontological Mitigation which is generally required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during construction. The Protocol for a Chance Find and Management Plan is attached (Appendix 2) for the ECO.

b. This project will benefit the environment, economy, and social development of the community.

c. Preferred choice: Only one is presented (see Executive Summary).

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed, and a palaeontologist should be called in to determine proper mitigation measures.

Sampling and collecting (1m,1k):

Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

a. Objections: Cautious. See heritage value and recommendation.

- b. Conditions of development: See Recommendation.
- c. Areas that may need a permit: Only if a fossil is unearthed.
- d. Permits for mitigation: **SAHRA/PHRA**.

K. Conclusions

- a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
- b. All information needed for the Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by Bateleur Environmental & Monitoring Services.
- c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
- d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures, especially for shallow caves.
- e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment (fossils) and adjacent areas as well as for safety and security reasons.

L. Bibliography

- ALMOND, J., PETHER, J, and GROENEWALD, G. 2013. South African National Fossil Sensitivity Map. SAHRA and Council for Geosciences.
- BRANDL, G. 1985. 1:250 000 Geological Map 2328 of Pietersburg. SACS, Council for Geoscience, Pretoria.
- DE ZANCHE, V. and MIETTO, P. 1977. *The World of Fossils*. Sampson Low Guides, Berkshire, Printed in Italy, Pp 256.
- GROENEWALD, G. and GROENEWALD, D. Palaeotechnical Report of the Limpopo Province. SAHRA. Pp 22.
- KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatsana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy. Handbook 8, Part 1, pp 690.*
- MACRAE, C. 1999. *Life Etched in Stone: Fossils of South Africa*. Geological Society of South Africa, Pg 1-289.
- MCCARTHY, T and RUBIDGE, B. 2005. *The Story of Earth Life: A southern African perspective on a 4.6-billion-year journey*. Struik. Pp 333.
- NIXON, N., ERIKSSON, P.G., JACOBS, R. and SNYMAN, C.P. 1988. Early Proterozoic micro-algal structures in carbonaceous shales of the Pretoria Group, south-west of Potchefstroom. *South African Journal of Science*, **84**: 592-595.
- NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys*. De Beers, Struik, P 1-320.
- RUBIDGE, B. S. (ed.), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1, 46pp. Council for Geoscience, Pretoria.
- SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.
- SNYMAN, C. P., 1996. *Geologie vir Suid-Afrika*. Departement Geologie, Universiteit van Pretoria, Pretoria, Volume 1, Pp. 513.
- VAN DER WALT, M., DAY, M., RUBIDGE, B. S., COOPER, A. K. & NETTERBERG, I., 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. *Palaeontologia Africana*, **45**: 1-5.

VISSER, D.J.L. 1984 (ed). Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

VISSER, D.J.L. 1989 (ed). *Toeligting: Geologiese kaart (1:100 000). Die Geologie van die Republieke van Suid Afrika, Transkei, Bophuthatswana, Venda, Ciskei en die Koningkryke van Lesotho en Swaziland.* South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

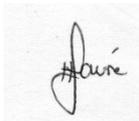
Declaration (disclaimer) 1(b)

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

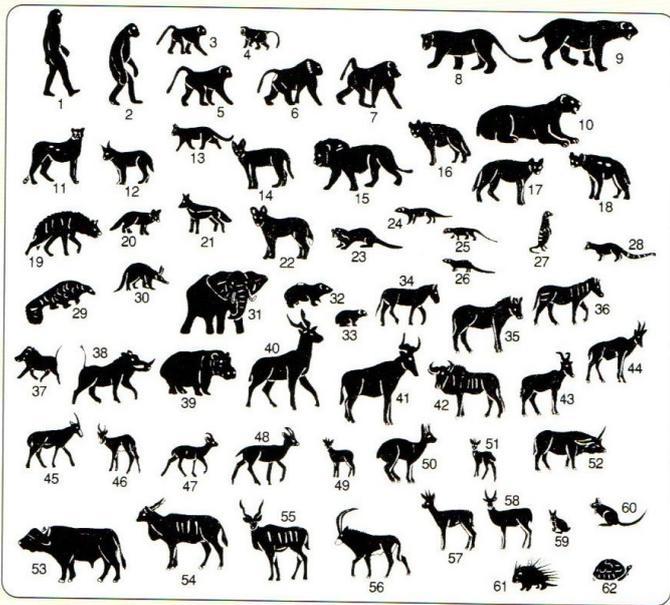
It may be possible that the Desktop Study may have missed palaeontological resources in the project area as outcrops are not always present or visible due to vegetation while others may lie below the overburden of earth and may only be present once development commences.

This report may not be altered in any way and any parts drawn from this report must make reference to this report.



Heidi Fourie
2019/07/30

Appendix 1: Examples of Quaternary age fossils.



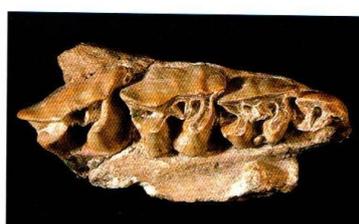
Silhouette representation of the larger vertebrates whose remains are represented in Members 1-3 of the Swartkrans site on the outskirts of the town of Krugersdorp. Numbers after each taxon comprise minimum numbers of individuals represented in the remains of the lower bank (Member 1), hanging remnant (Member 1), Member 2 and Member 3 respectively.

Courtesy of Dr C.K. Brain.
Museum of Natural History, Pretoria

FAUNA FROM MEMBERS 1 - 3, SWARTKRANS (Makapanian Mammal Age)
 Courtesy Dr B. Brain, - Museum of Natural History, Pretoria

1: *Homo erectus* (man) 1,3,2,0. 2: *Australopithecus robustus* (robust apeman) 13,87,17,9. 3: *Parapapio jonesi* 0,8,0,0. 4: *Cercopithecoides* sp. 1,0,0,0. 5: *Papio hamadryas robinsoni* 6,38,8,11. 6: *Theropithecus oswaldi danieli* 1,17,1,14. 7: *Dinopithecus ingens* 1,26,0,0. 8: *Panthera pardus* (leopard) 4,12,2,5. 9: *Dinofelis* sp. (false sabre-toothed cat) 0,1,0,0. 10: *Meganthereon* sp. (dirk-toothed cat) 0,1,0,1. 11: *Acinonyx jubatus* (cheetah) 0,1,0,1. 12: *Felis caracal* (caracal) 1,0,0,0. 13: *Felis lybica* (African wild cat) 0,0,0,1. 14: *Felis serval* (serval) 1,0,0,0. 15: *Panthera leo* (lion) 1,1,0,0. 16: *Hyaena brunnea* (brown hyaena) 1,4,2,3. 17: *Chasmaporthetes nitidula* (hunting hyaena) 2,8,1,2. 18: *Crocuta crocuta* (spotted hyaena) 0,2,1,1. 19: *Proteles* sp. (large fossil aardwolf) 1,1,0,1. 20: *Vulpes* sp. (fox) 0,2,0,3. 21: *Canis mesomelas* (black-backed jackal) 3,4,4,5. 22: Large canid gen. and sp. indet. 0,0,1,1. 23: *Aonyx capensis* (Cape clawless otter) 2,0,1,2. 24: *Atilax* sp. (water mongoose) 0,0,1,1. 25: *Cynictis penicillata* (yellow mongoose) 0,0,1,1. 26: *Herpestes ichneumon* (large grey mongoose) 1,0,0,0. 27: *Suricata suricatta* (suricate) 0,0,2,1. 28: *Genetta tigrina* (large-spotted genet) 0,0,0,1. 29: *Manis* sp. (pangolin) 0,0,0,1. 30: *Orycteropus afer* (antbear) 1,0,1,1. 31: cf. *Elphas* sp. 2,0,0,1. 32: *Procavia transvaalensis* (large fossil dassie) 3,8,3,5. 33: *Procavia antiqua* (fossil dassie) 17,16,10,11. 34: *Hipparion lybicum steytleri* (three-toed horse) 1,1,1,1. 35: *Equus capensis* (giant Cape horse) 2,6,3,5. 36: *Equus burchelli* (Burchell's zebra) 0,0,0,1. 37: *Phacochoerus* sp. (warthog) 1,0,3,1. 38: cf. *Tapinochoerus meadowsi* (large fossil pig) 1,7,1,1. 39: *Hippopotamus* sp. (hippopotamus) 1,0,0,1. 40: Giraffid 0,1,1,1. 41: *Megalotragus* sp. (giant hartebeest) 0,3,1,3. 42: *Connochaetes* sp. (wildebeest) 7,19,7,7. 43: Medium alcelaphine: *Alcelaphus* sp. or *Beatragus* sp. (hartebeest) 3,22,3,6. 44: *Rabaticerus porrocornutus* 0,2,0,0. 45: *Damaliscus* sp. (blesbok) 2,4,6,6. 46: *Antidorcas marsupialis australis* (springbok) 11,0,10,18. 47: *Antidorcas recki* 0,6,2,1. 48: cf. *Gazella* sp. (gazelle) 5,6,5,14. 49: *Oreotragus oreotragus* (klipspringer) 1,0,0,1. 50: *Oreotragus major* (fossil klipspringer) 0,1,0,0. 51: *Raphicerus campestris* (steenbok) 1,0,1,3. 52: *Makapania* sp. (musk ox) 0,3,0,0. 53: *Syncerus* sp. (buffalo) 2,3,2,3. 54: *Taurotragus oryx* (eland) 0,0,1,1. 55: *Tragelaphus strepsiceros* (kudu) 0,4,0,1. 56: *Hippotragus* cf. *niger* (sable) 0,0,1,3. 57: *Pelea* sp. (rhebok) 0,2,0,2. 58: *Redunca arundinum* (reedbuck) 0,1,0,0. 59: Lagomorph gen. and sp. indet. (hare) 9,0,4,7. 60: *Pedetes* sp. (springhare) 1,0,1,1. 61: *Hystrix africaeaustralis* (porcupine) 2,2,1,2. 62: *Chelonia* indet. (tortoise) 1,0,2,2.





Left: Teeth of the white rhino *Ceratotherium simum* from Makapansgat. **Right:** View from above shows the sharp cutting edges of the tooth row of this predominant grazer. Specimen 170 mm long.

In the collection of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Johannesburg.
 Photograph C.S. MacRae

Appendix 2 (1k,1m,1q): Protocol for Chance Finds and Management plan

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW**; this process guides the palaeontologist / palaeobotanist on site and should not be attempted by the layman / developer. As part of the Environmental Authorisation conditions, an Environmental Control Officer (ECO) will be appointed to oversee the construction activities in line with the legally binding Environmental Management Programme (EMPr) so that when a fossil is unearthed they can notify

the relevant department (SAHRA) and specialist to further investigate. Therefore, the EMPr must be updated to include the involvement of a palaeontologist during the digging and excavation (ground breaking) phase of the development.

The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction/development activities. When a fossil is found, the area must be fenced-off with a 30 m barrier and the construction workers must be informed that this is a no-go area. The ECO should familiarise him- or herself with the fossiliferous formations and its fossils. A monthly site visit after blasting or excavating is recommended and the keeping of a photographic record when feasible. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Fossils.

The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
2. Fossils likely to occur are for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from the Volksrust Formation (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once a week).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Use Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils is visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

SAHRA Documents:

Guidelines to Palaeontological Permitting Policy.

Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.

Guidelines for Field Reports.

Palaeotechnical Reports for all the Provinces.

Appendix 3: Table of Appendix 6 requirements.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats

	1(n)i	Concerns/threats
	1(n)ii	Concerns/threats
	1(o)	Concerns/threats
	1(p)	Concerns/threats
D	1(h)	Figures
	1(a)i	Terms of reference
H	1(e)	Description of Methodology
	1(i)	Assumptions and Limitations
I	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	Recommendation
	1(m)	Sampling and collecting
	1(k)	Sampling and collecting
Declaration	1(b)	Declaration
Appendix	1(k)	Protocol for finds
	1(m)	Protocol for finds
	1(q)	Protocol for finds