The Proposed Diamonds Alluvial & Diamonds General Prospecting Right near Schweizer Reneke on Portion 2 and a certain Extent of the Remaining Extent of the Farm Kameelkuil 88, Registration Division: HO, North West Province

Dr Ruth Segomotsi Mompati District Municipality, Mamusa Local Municipality, North West Province

Farm: Kameelkuil 88

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 993 3110

Palaeontological Impact Assessment: Desktop Study

Facilitated by: Milnex

P.O. Box 1086, Schweizer Reneke, 2780

018 011 1925

2017/11/24

Ref: DMR NW30/5/1/1/2/12152PR

B. Executive summary

Outline of the development project: Milnex has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Desktop Study of the suitability of the Proposed Diamonds Alluvial & Diamonds General Prospecting Right application near Schweizer Reneke on Portion 2 and a certain Extent of the Remaining Extent of the Farm Kameelkuil 88, Registration Division: HO within the North West Province.

The applicant proposes to prospect for diamonds alluvial and diamonds general near Schweizer Reneke.

The Project includes one Alternative (Figure 2):
Alternative 1: An area blocked in red and located approximately 18.4 kilometers South East of Schweizer Reneke town. The size of the site is approximately 396.1784 hectares covered by the application.

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.

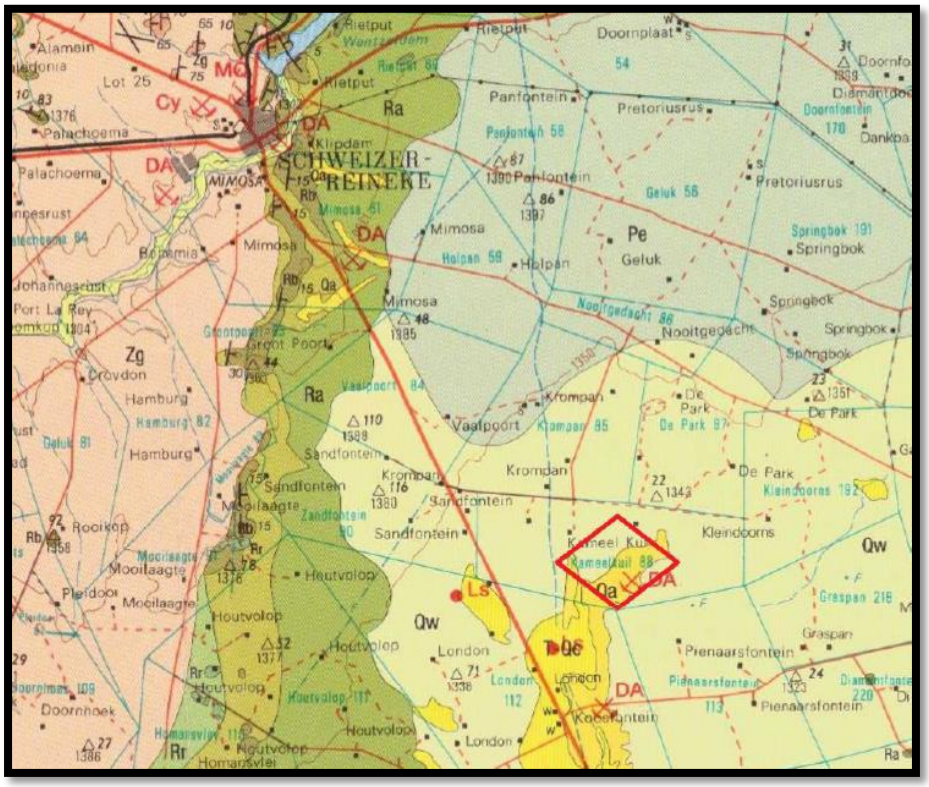
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
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, 2724 Christiana Geological Map (Grobler 1996).

Figure 3: The geology of the development area.



Legend to map and short explanation.
Qw – Aeolian sand (yellow). Quaternary.
Qa – River-terrace gravel; diamondiferous in places (dark yellow). Quaternary.
T-Qc – Calcrete (dark yellow). Kalahari Group. Quaternary.
Pe – Sandstone and shale (grey). Ecca Group, Karoo Supergroup. Ecca.
Ra – Tholeiitic and calc-alkaline basalt and andesite; tuff and pyroclastic breccia (green). Allanridge Formation, Ventersdorp Supergroup. Randium.
□ – Position of proposed Prospecting (in red).

Mining Activities:
DA – Diamond Alluvial.

Summary of findings (1d): The Desktop Study was undertaken in November of 2017 in the summer in dry and hot conditions. As this is a desktop study the season and conditions has no influence on the outcome and the following is reported:

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).

Alluvial diamonds originates from Kimberlite. Kimberlite is a heavy, brecciated rock which contains rounded olivine crystals in a serpentine matrix. At present there are two types of kimberlite, micaceous and basaltic. Its age is Late Cretaceous (77-120 Ma as well as 1 250 Ma) (Kent 1980). Kimberlite occurs in sills, pipes or plates and occurs in groups. It is characterised by yellow and blue weathered soils (Snyman 1996). There are eight sub-provinces of kimberlite occurrences (Visser 1989).

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 Karoo Supergroup strata the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **HIGH** for the Quaternary (Q) and **LOW** for the Kimberlite (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The potential impact of the development on fossil heritage is **HIGH, but LOW** for the Kimberlite and therefore a Desktop Study was conducted. A Phase 1 PIA and or mitigation are not recommended unless a fossil is found. The application is for the prospecting rights and does not include mining or developing of the site.

During the study it was found that part of the site is directly underlain by the Quaternary (Qa, Qw, T-Qc), and is presently underutilised. The site has been mined and used for agriculture.

The Project includes one Alternative (Figure 2):
Alternative 1: An area blocked in red and located approximately 18.4 kilometers South East of Schweizer Reneke town. The size of the site is approximately 396.1784 hectares covered by the application.

Concerns/threats (1g,1ni,1nii,1o,1p) to be added to 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 activities, 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 during construction not to intrude surrounding or underlying fossiliferous layers. An appropriate protocol and management plan is attached (Appendix 1).
3. Mitigation is needed if a fossil or traces of it is found (Appendix 1). Permission is needed from SAHRA.
4. The Environmental Control Officer must check for fossils. If a fossil is found, all prospecting must stop, and SAHRA must be notified. A palaeontologist must be called in to excavate.

Recommendations are:

1. The prospecting can go ahead, no consultation with parties was necessary.
2. No further palaeontological studies are necessary.

3. The prospecting can go ahead with caution, the ECO must survey for fossils during ground breaking and digging or drilling in line with the legally binding Environmental Management Programme (EMPr), this must be updated to include the involvement of a palaeontologist to train staff or visit the site.

Stakeholders: Developer – N/A.
Environmental – Milnex, Posbus 1086, Schweizer-Reneke, 2780.
Landowner – P.O. Box 309, Schweizer Reneke, 2780.

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 R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 1).

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. 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 found.

The applicant proposes to prospect for diamonds alluvial and diamonds general near Schweizer Reneke.

Prospecting rights have been applied for in the vicinity of the proposed area, around Schweizer Reneke. It is assumed that diamond bearing gravel might be present on the proposed area. Diamondiferous gravels in the North West Province are distributed predominantly in three major areas, namely the area underlain by dolomite from the east of Ventersdorp towards Lichtenburg and Bakerville and beyond (VLB), the Lichtenburg-Delareyville-Bloemhof-Klerksdorp-Lichtenburg area (LDBKL), which is mostly underlain by Ventersdorp Supergroup basalt and Dwyka Group tillite, and the area associated with the Vaal River terraces and gravels.

Adjacent properties have yielded alluvial diamonds. Bulk sampling will be done after pitting by drilling and sampling 52 800 tons in order to determine the grades and size distribution. Box cuts will be 20m wide x 30m long and 2m deep.

Associated infrastructure:

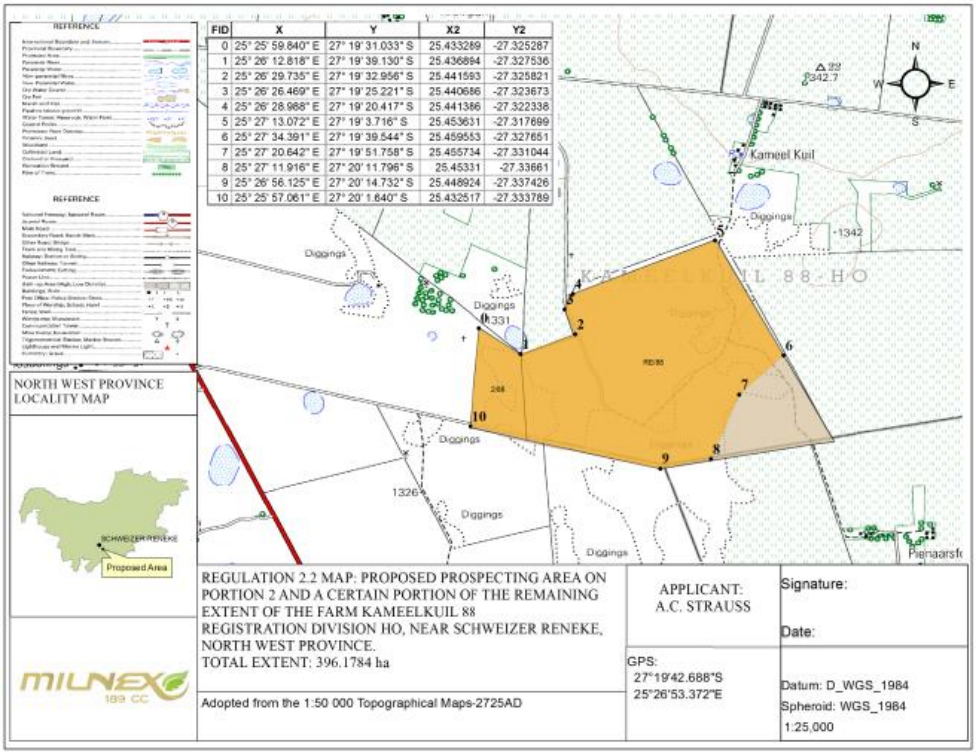
1. Buildings (mobile office, ablution, sort house),
2. Roads,
3. Amenities (non-permanent).

Rezoning/ and or subdivision of land: Yes, from Agriculture to Mining.
Name of developer and consultant: N/A and Milnex.
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. For the past ten years she carried out field work in the Eastern Cape, Free State, Gauteng, Limpopo and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 23 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 by loading it on SAHRIS.

E. Description of property or affected environment
Location and depth:
The proposed Prospecting Right application of Diamond Alluvial and Diamond General will be situated near Schweizer Reneke on Portion 2 and a certain Extent of the Remaining Extent of the Farm Kameelkuil 88, Registration Division: HO within the North West Province.

The depth is dependant on the thickness of the formation and the depth of the foundations, footings, channels and trenches. The trenches will not be deeper than 2 m.

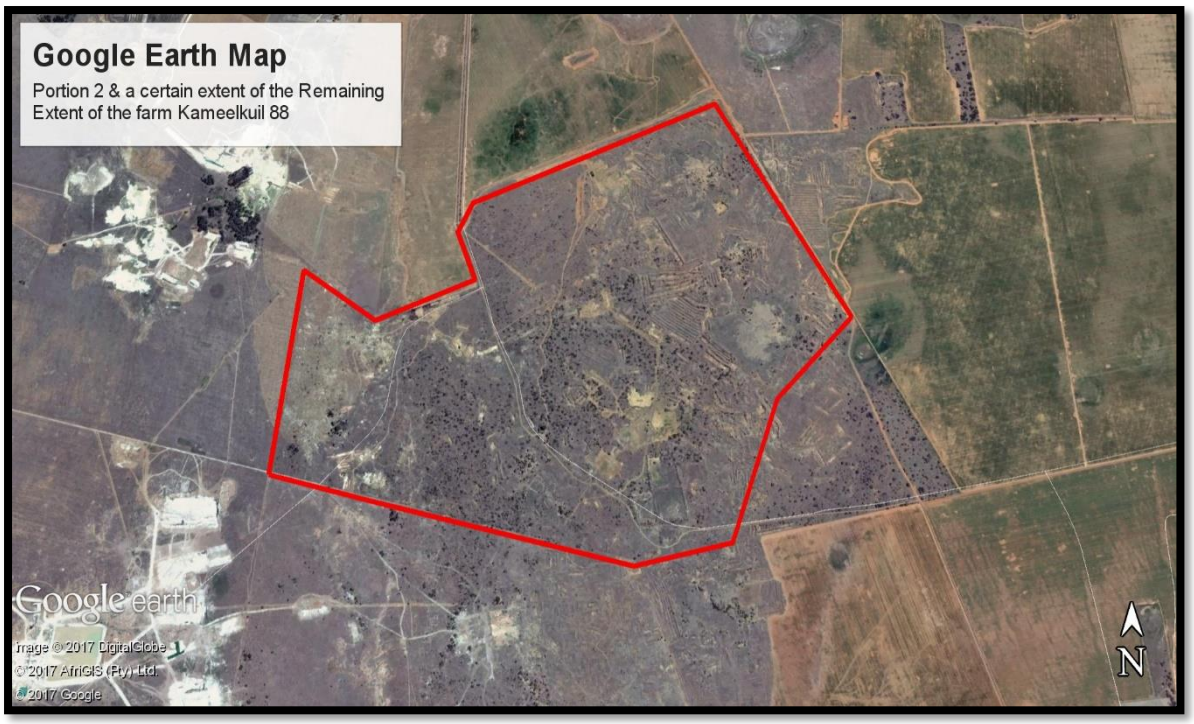
Figure 1: Topographic map to show location of proposed site (Milnex)



The Project includes one Alternative (Figure 2):

Alternative 1: An area blocked in red and located approximately 18.4 kilometers South East of Schweizer Reneke town. The size of the site is approximately 396.1784 hectares covered by the application.

Figure 2: Google.earth image showing location (Milnex).



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).

The Cenozoic aged Kalahari Group underlies extensive areas containing trace fossils of tubes and borings, ostracods, bivalves, gastropod shells, and diatoms and is mostly covered in windblown sand of the Gordonia Formation (Groenewald and Groenewald 2014). The Kalahari Group consists of four formations namely, the Wessels Formation at the bottom, the Budin Formation, the Eden Formation and the Gordonia Formation at the top (Visser 1989). The Gordonia Formation is well developed in the Gordonia District as cover sands and fossil dunes (Kent 1980).

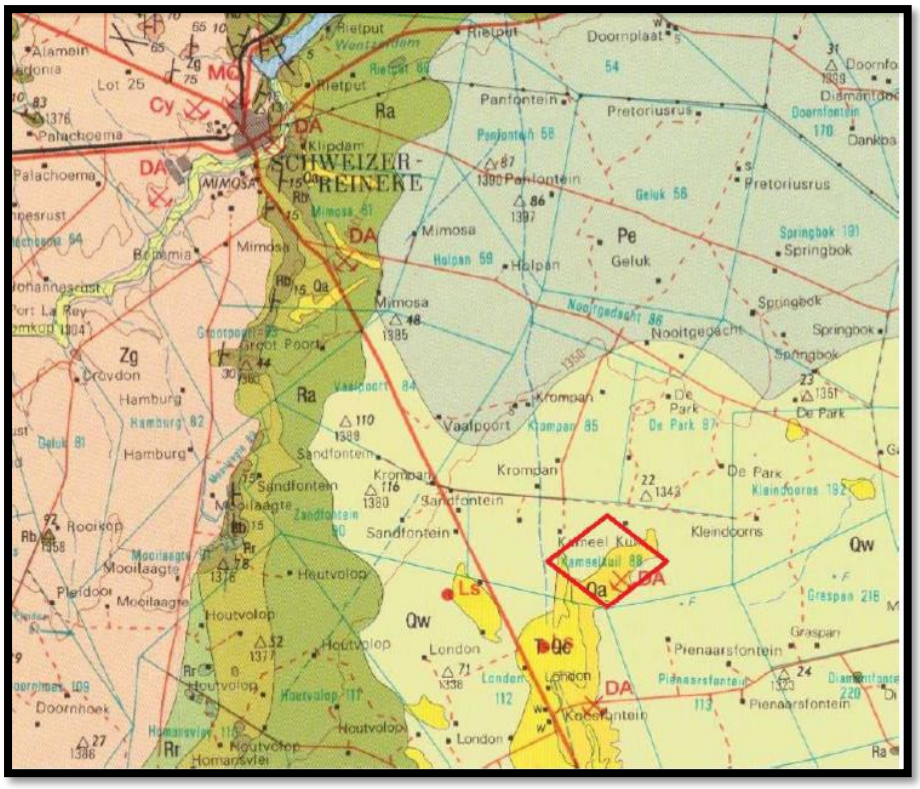
All along the N12 towards George in the Ventersdorp Supergroup one finds gravels of a much younger generation being dug over for their diamonds. Wolmaranstad being the heart of the diamond trade. Diamonds were carried by rivers from pipes and fissures far to the north to deposit them in the Vaal. From there, some of the gems were carried westwards to the Orange River at Douglas and on to the West Coast, others were deposited in these parts (Norman and Whitfield 2006).

Alluvial diamonds originates from Kimberlite. The Kimberley pipe of the Kimberley mine ("Big Hole") outcropped as a small hill and the DuToitspan manifested as a pan with no outcrop at all. Kimberlite is a heavy, brecciated rock which contains rounded olivine crystals in a serpentine matrix. At present there are two types of kimberlite, micaceous and basaltic. Its age is Late Cretaceous (77-120 Ma as well as 1 250 Ma) (Kent 1980). Kimberlite occurs in sills, pipes or plates and occurs in groups. It is characterised by yellow and blue weathered soils (Snyman 1996). There are eight sub-provinces of kimberlite occurrences (Visser 1989).

Large areas of the southern African continent are covered by the Karoo Supergroup. The Ecca Group (Pe) is early to mid-Permian (545-250 Ma) in age. Sediments of the Ecca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Ecca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Ecca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. It consists essentially of mudrock (shale), but sandstone-rich units occur towards the margins of the present main Karoo basin in the south, west and north-east, with coal seams also being present in the north-east (Kent 1980, Johnson 2009).

Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). Dolerite dykes occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

Figure 3: Excerpt of 1:250 000 Geological Map 2724 Christiana (Grobler 1996).



Legend to map and short explanation.

Qw – Aeolian sand (yellow). Quaternary.

Qa – River-terrace gravel; diamondiferous in places (dark yellow). Quaternary.

T-Qc – Calcrete (dark yellow). Quaternary.

Pe – Sandstone and shale (grey). Ecca Group, Karoo Supergroup. Ecca.

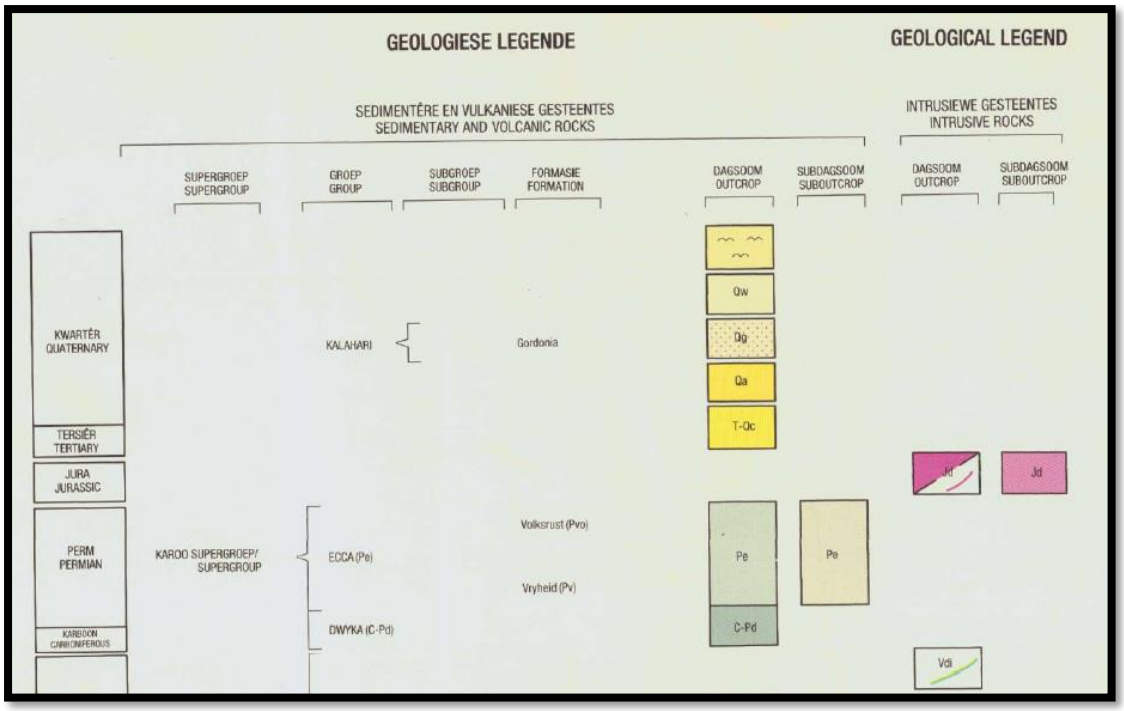
Ra – Tholeiitic and calc-alkaline basalt and andesite; tuff and pyroclastic breccia (green). Allanridge Formation, Ventersdorp Supergroup. Randium.

□ – Position of proposed Development (in red on figure).

The Project includes one Alternative (Figure 3):

Alternative 1: An area blocked in red and located approximately 18.4 kilometers South East of Schweizer Reneke town. The size of the site is approximately 396.1784 hectares covered by the application.

Figure 4: Lithostratigraphic column to show the geological formations present (Bosch and Visser 1994).



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 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 the roads, services and parking areas.

Fossils will be present in caves, calc tufa and pans and examples are a wide range of mammalian bones and teeth, tortoise remains, ostrich egg, non-marine mollusc shells, ostracods, diatoms, other micro fossils, trace fossils, stromatolites, plant remains and wood (Groenewald and Groenewald 2014).

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).

The Ecca Group may contain fossils of diverse non-marine trace, *Glossopteris* flora, mesosaurid reptiles, palaeoniscid fish, marine invertebrates, insects, and crustaceans (Johnson 2009). *Glossopteris* trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the

northern part of the Karoo Basin that the glossopterids and cordaitales, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge 2005).

Marine invertebrates, including cephalopods, bivalves and brachiopods, have been found near the base of the Prince Albert Formation at Douglas (WSW of Kimberley) (Johnson 2009). Cephalopods, brachiopods (*Attenuatella*) and lamellibranchs (*Phestia, Nuculopsis*) are found in calcareous concretions, which also contain palaeoniscoid fish (*Namaichthys*) , coprolites, fossil wood (*Glossopteris*), and the mineral glauberite. Localities are on Blaauw Krantz and Zand Bult (McLachlan and Anderson 1973). Fossil shark (*Neurocranium*) also occurs near Klaarstroom and ichnofossils near Kimberley (Cole 2005).

Subgroup / Supergroup	Group	Formation	Fossil Heritage	Comment
Quaternary	Kalahari	Gordonia	Very wide range of possible fossil remains, although these are sparse.	Not well studied.
Karoo Supergroup	Ecca	Ecca	Rich range of plant fossils (*Glossopteris* flora), palynomorphs, rare insects, marine invertebrates, wood, non-marine trace.	-

Table 1: Taken form palaeotechnical report (Groenewald and Groenewald 2014).

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 Karoo Supergroup strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **HIGH** for the Quaternary and **LOW** for the kimberlite.

Rock Unit	Significance/vulnerability	Recommended Action
Quaternary (Q)	High	Desktop study is required, Phase 1 may be recommended
Ecca (Pe)	Very High	Phase 1 is recommended
Kimberlite	Low	No study
Ventersdorp	Low	No study

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA) (Groenewald & Groenewald 2014).

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: **HIGH** for the Quaternary. There are significant fossil resources that may be impacted by the development. The Kimberlite has a **LOW** palaeontological sensitivity.

H. Description of the Methodology (1e)
The palaeontological impact assessment desktop study was undertaken in November 2017. A literature survey is included.

Assumptions and Limitations:-
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. Insufficient data from developer and exact lay-out plan for all structures.

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 11: 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 111: 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 11 heritage resources.
> Local authorities identify and manage Grade 111 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.

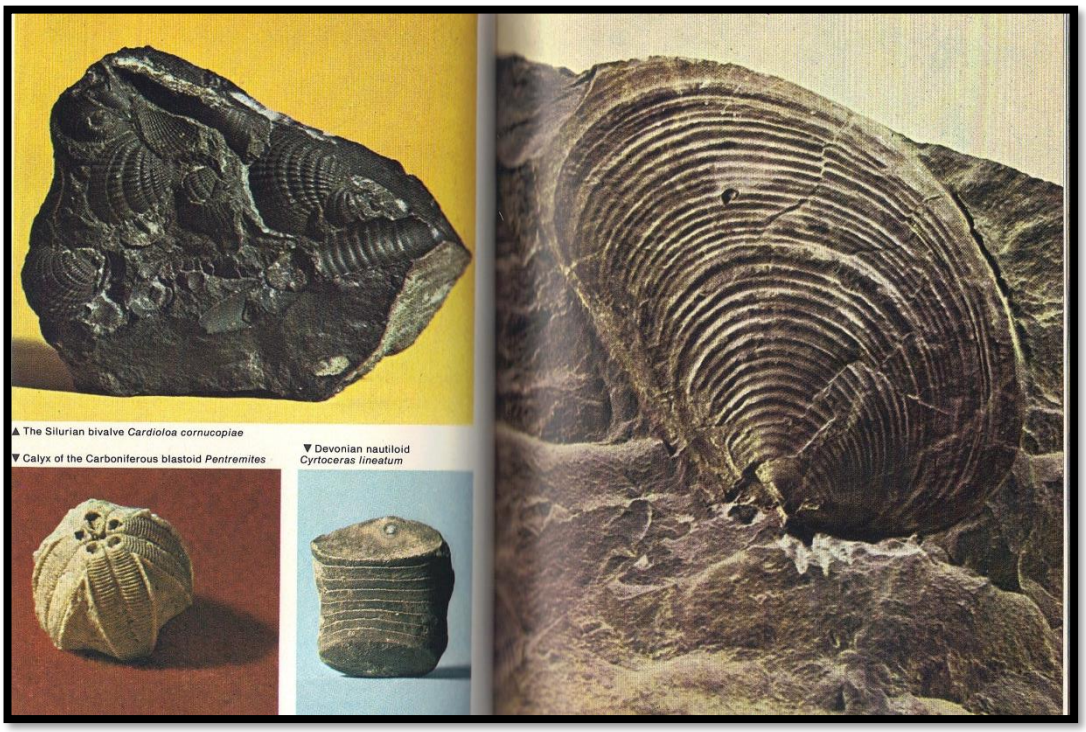
When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded 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)

Examples of fossils present in archaeological sites of the Quaternary. The Cenozoic aged Kalahari Group underlies extensive areas containing trace fossils of tubes and borings, ostracods, bivalves, gastropod shells, and diatoms and is mostly covered in windblown sand of the Gordonia Formation (Groenewald and Groenewald 2014) also marine invertebrates, including cephalopods, bivalves and brachiopods, have been found near the base of the Prince Albert Formation at Douglas (WSW of Kimberley) (Johnson 2009). Cephalopods, brachiopods (*Attenuatella*) and lamellibranchs (*Phestia, Nuculopsis*) are found in calcareous concretions, which also contain palaeoniscoid fish (*Namaichthys*) , coprolites, fossil wood (*Glossopteris*), and the mineral glauberite.

Figure 4: Examples of invertebrate fossils.



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, the sealing-in or destruction of fossils by development, vehicle traffic, mining activities or 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, and it is not necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops unless fossils are found. A Phase 2 Palaeontological Mitigation is not required. Protocol is attached (Appendix 2).

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

c. Preferred choice: The impact on the palaeontological heritage is **HIGH.** The presence of fossils may be problematic (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, the area must be fenced off 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: Discussed.
d. Permits for mitigation: **Needed from 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 Milnex.
c. Areas that would involve mitigation (dam Site A) 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 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 Geoscience, Pretoria.

COLE, D.I. 2005. Prince Albert Formation [Ecca Group] [Permian]. Catalogue of South African Lithostratigraphic Units, SA Committee for Stratigraphy, Council for Geoscience, **8:** 8-33 – 8-36.

GROBLER, D.F. 1996. 1:250 000 Geological Map 2724 of Cristiana. South African Committee for Stratigraphy, Council for Geoscience, Pretoria.

GROENEWALD, G. and GROENEWALD, D. 2014. SAHRA Palaeotechnical Report: Palaeontological Heritage of the North West Province. South African Heritage Resources Agency, Pp 1-24.

JOHNSON, M.R. 2009. Ecca Group [Karoo Supergroup] [Permian]. Catalogue of South African Lithostratigraphic Units, SA Committee for Stratigraphy, Council for Geoscience, **10:**10-5-10-7.

KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy.* Handbook 8, Part 1, pp 690.

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.

MCLACHLAN, I.R. and ANDERSON, A. 1973. A review of the evidence for marine conditions in southern Africa during Dwyka Times. *Palaeontologia Africana,* **15(2):** 37-64.

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. 2013. *Geology of the Beaten Track: Exploring South Africa's hidden treasures.* De Beers, Struik Nature, Pp 256.

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.
VISSER, J.N.J., VON BRUNN, V. and JOHNSON, M.R. 1990. Dwyka Group. Karoo Sequence. Catalogue of South African Lithostratigraphic Units. SACS **2:** 15-17.

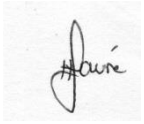
Declaration (disclaimer) (1b)

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 on geological maps 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
2017/11/24

Appendix 1: **Protocol for 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 /ECO on site and should not be attempted by the layman / developer. The developer will employ an Environmental Control Officer (ECO) to oversee the construction activities so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. The ECO should familiarise him- or herself with the applicable formations and its fossils. Miners and construction workers should be informed that fenced-off areas are no-go areas. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of fossils.

As part of the Environmental Authorisation conditions, an Environmental Control Officer (ECO) will be appointed to oversee the construction activities in line with legally binding Environmental Management Programme (EMPr). The EMPr already covers the conservation of heritage and palaeontological artefacts that may be exposed during construction activities. The protocol is to immediately cease all construction activities and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist during the digging and excavation phase of the development.

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) / ECO must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, fence off areas, and put the development on hold.
5. If the palaeontologist / palaeobotanist / ECO 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 / ECO 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 / ECO 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 guidelines 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. Using 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 are 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 2: Listing points in Appendix 6 of the Act and position in Report.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"
	1(p)	"
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)	"
	1(m)	Sampling and collecting
	1(k)	"
Declaration	1(b)	Declaration
Appendix 2	1(k)	Protocol for finds
	1(m)	"
	1(q)	"