Opening of Ek Kraal quarry

Karoo Hoogland Local Municipality, Namakwa District Municipality, Northern Cape Province

Farm: Portion 1 of Ek Kraal 199-RD

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 942 0110 x 1057

Palaeontological Impact Assessment: Phase 1 Field Study

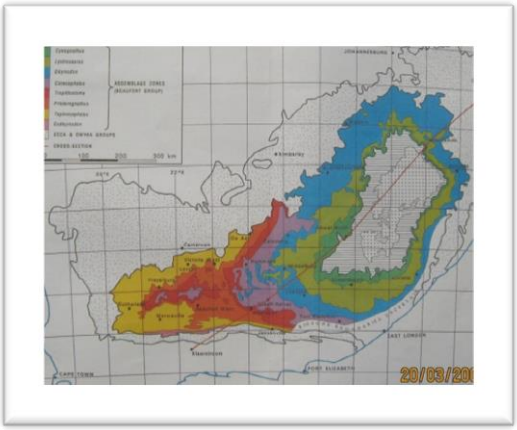
Facilitated by: Chameleon

P.O. Box 11788, Silver Lakes, Pretoria, 0054

Tel: 082 571 6920

2018/07/18

Ref: DMR NC30/5/1/3/2/10667MP



A. Executive summary

Outline of the development project: Chameleon Environmental has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field Study of the suitability of the Proposed Opening of Ek Kraal quarry near Sutherland on the Farm Ek Kraal 199-RD, in the Karoo Hoogland Local Municipality, Namakwa District Municipality, with related infrastructure in the Northern Cape Province.

The applicant, Concor Infrastructure intends to open a new gravel quarry approximately 40 km north of Matjiesfontein.

The Project includes one Alternative (see google.earth image):
The area mined will be 1.5 hectares in size and the entire area will be 4.42 ha in extent.

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.

"palaeontological" means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.

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).

Figure 2: The geology of the development area.

Legend to Map and short explanation.
Pa – Mudstone, sandstone (green). Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Permian.
Pko – Sandstone, shale (brown). Koedoesberg Formation, Ecca Group, Karoo Supergroup. Permian.
Pk - Shale (light brown). Kookfontein Formation, Ecca Group, Karoo Supergroup. Permian.
Ps – Shale, sandstone (dark brown). Skoorsteenberg Formation, Ecca Group, Karoo Supergroup. Permian.
□ – Development (in black on the Figure).
↓ - Dip.
--f-- - Fault.

Mining Activities
◊ - Diamonds.

Summary of findings: The Palaeontological Impact Assessment: Phase 1: Field Study was undertaken in July 2018 in the winter in very wet, snowy (-1 to 2˚C), rainy, cold and windy conditions (Appendix 6 of Act, 1(d)), and the following is reported:

The development is taking place on the Abrahamskraal Formation, Adelaide Subgroup of the Karoo Supergroup.

The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. An estimated age is 150 – 180 Ma. and a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts (Kent 1980, Snyman 1996). The Beaufort Group is underlain by the Ecca Group which is underlain by the Dwyka Group.

The main Karoo basin is divided into eight Biozones called Assemblage Zones characterised by specific groups of fossils. This development lies on the *Tapinocephalus* Assemblage Zone (known for its fossil wealth).

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 rocks the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **VERY HIGH** for the Adelaide Subgroup (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The impact of the development on fossil heritage is **VERY HIGH** and therefore a field survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment and or mitigation were done. The walk through did not locate any fossils.

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

Rock Unit	Significance/vulnerability	Recommended Action
Adelaide Subgroup	Very High	Field assessment and protocol for finds is required

- 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 if a fossil is unearthed, construct a barrier of 30 m, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist for training of the ECO.
- The EAP as well as the ECO must be made aware of the fact that sediments of the Beaufort Group are well-known for the very high content of significant plant and vertebrate fossils.
- The ECO must visit the site bi-weekly and keep a photographic record during construction of structures. Some mines employ an ECO for Life of Mine.

The Project includes one Alternative (see google.earth image):
The area mined will be 1.5 hectares in size and the entire area will be 4.42 ha in extent.

Concerns/threats (1g,1ni,1nii,1o,1p) to form part of the EMPr:

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, digging of foundations, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic, mining activities and human disturbance.
2. The overburden and inter-burden must always be surveyed by the ECO for fossils during construction. 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 fossiliferous layers.

3. Mitigation may be needed if a fossil is found, in this case, the area must be fenced off with a 30 m barrier, and a palaeontologist must be called to excavate (Appendix 3).
4. No consultation with parties was necessary, but very little information from the developer was available for this study.
5. The mine plant has one Alternative.
6. The walk through did not find fossils as the area is covered with lush vegetation. Once vegetation is cleared outcrops will be more visible.

Stakeholders: Developer – Concor Infrastructure, P.O. Box 585, Block A, 2 Arbroath Road, Bedfordview, 2008. Tel: 086 651 5138.
Environmental – Chameleon Environmental, P.O. Box 11788, Silver Lakes, 0054.
Landowner – Douglas Caldo, P.O. Box 75, Laingsburg, 6900.

C. Table of Contents

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 2).

Outline of development

This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction or construction phase it may be necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA).

The applicant, Concor Infrastructure intends to open a new gravel quarry approximately 40 km north of Matjiesfontein. The amount of approximately 80 000 m³ will be mined from the quarry for the Wind Farms Development. This quantity may increase a additional work in the area is secured. The depth of the quarry should not exceed 20 m in depth. It is opencast.

The following infrastructure is anticipated:

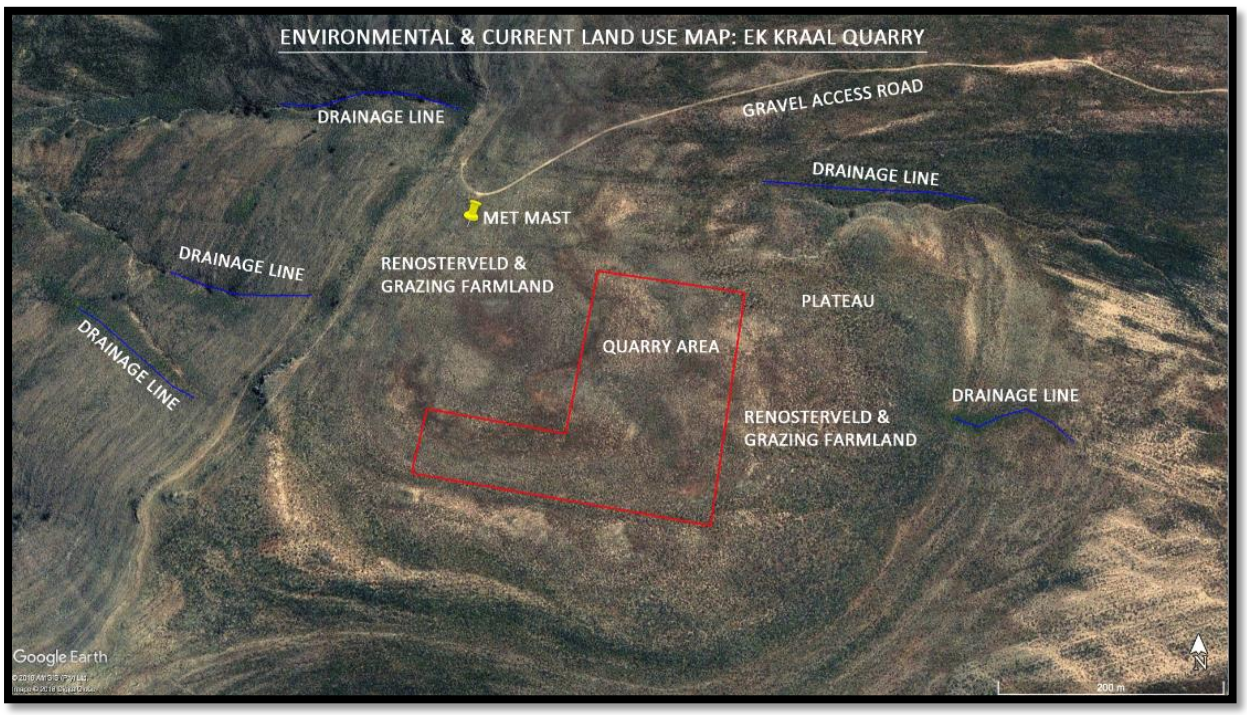
1. Generator and fuel storage,
2. Crusher,
3. Screening plant,
4. Gravel stockpiles,
5. Offices and ablution facilities,
6. Weigh bridge,
7. Stockpiles: subsoil, overburden, spoil, topsoil.

The gravel material will be used as aggregate in the concrete turbine bases between turbines on the wind far close to the quarry. The proposed development is paramount to the success of the wind farm completion. Geological tests in the surrounding area show insufficient quality of gravel material for road construction practises and the cumulative impact of importing high volumes of suitable aggregate for the wind turbines' concrete bases will exceed the quarry's impact, therefore the need for the quarry is extremely high.

It was also found that no commercial sources are available in close proximity to the site that is suitable as aggregate for the concrete to be used in the wind turbine bases for the wind farm. The use of only commercial sources of gravel/aggregates for a project of this magnitude will also be inordinately expensive, and would render the project unviable. It was therefore, decided that investigations would be conducted to obtain aggregate material to be used for the wind farm construction in close proximity to the quarry.

Should the mining of the aggregate material not be allowed, the necessary material for the wind farm concrete of the turbine bases will not be available and the wind farm construction will not be completed.

Figure 1: View of quarry development (Chameleon).



The Project includes one Alternative (see google.earth image):
The area mined will be 1.5 hectares in size and the entire area will be 4.42 ha in extent.

Rezoning/ and or subdivision of land: No.
Name of Developer and Environmental Consultant: Concor Infrastructure and Chameleon Environmental.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment 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 13 years she carried out field work in the Eastern Cape, Limpopo, Mpumalanga, Gauteng, North West, Northern Cape and Free State 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.

E. Description of property or affected environment
Location and depth:
The Proposed Opening of Ek Kraal quarry near Sutherland on the Farm Ek Kraal 199-RD, in the Karoo Hoogland Local Municipality, Namakwa District Municipality, with related infrastructure in the Northern Cape Province.

Geological maps do not provide depth or superficial cover, it only provides mapable surface outcrops. Depth is determined by the related infrastructure such as foundations, trenches, footings and channels. The *Tapinocephalus* Assemblage Zone thins from about 2000 m south of Merweville and Beaufort West to ~600 m in the Aberdeen area, <200 m between Jansenville and Pearston and <100 m in the area south of De Aar. Sandstone occurs from 0-7 m, mudrock at 1-10 m and a combination of mudrock and sandstone at 10-20 m below surface.

The Project includes one Alternative (see google.earth image):
The area mined will be 1.5 hectares in size and the entire area will be 4.42 ha in extent.

The site is underlain by the Karoo Supergroup.

F. Description of the Geological Setting
Description of the rock units:
The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. An estimated age is 150 – 180 Ma. and a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts (Kent 1980, Snyman 1996). The Beaufort Group is underlain by the Ecca Group which is underlain by the Dwyka Group.

The southern part of the Karoo basin is 3000 m thick, but the northern part of the basin is much thinner. The animals present during Beaufort times flourished on the floodplanes, lakes and marshes. Sandstone is deposited in times of flooding in the river channels and the mudstones were deposited on the floodplains in the shallow lakes.

The Beaufort Group consists of greenish-grey, bluish-grey or red mudstones. Sandstones are often cross-bedded. Deposition is mainly terrestrial, river-dominated. Two subgroups are distinguished, the upper Tarkastad-

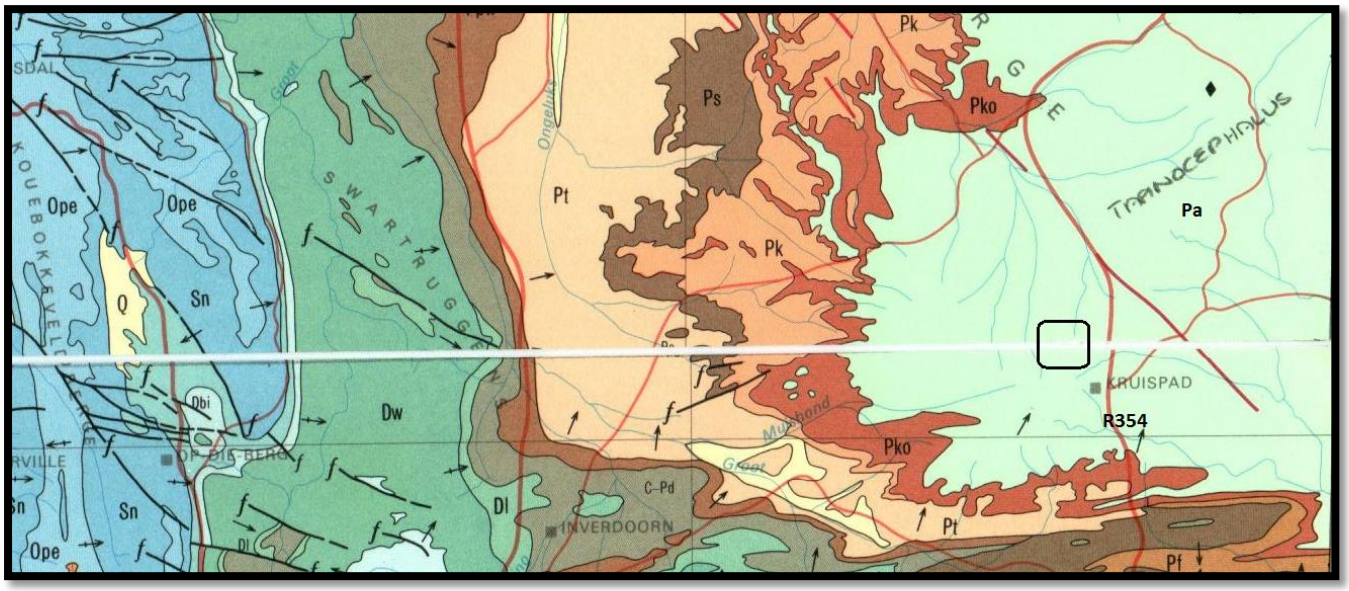
and the lower Adelaide Subgroups. The Tarkastad Subgroup possesses a greater abundance of both sandstone and red mudstone. The base of the Katberg Formation divides the two subgroups (Kent 1980). The Tarkastad Subgroup is not present in the study area.

The Tarkastad Subgroup is Early Triassic in age and conformably overlies the Adelaide Subgroup. Sandstone predominates and 'red' mudstone is more abundant above the contact of the two subgroups. In the northern Free State the Tarkastad Subgroup is divided into the Driekoppen Formation and the Verkykerskop Formation (Rubidge 1995).

The Adelaide Subgroup is divided into the Normandien Formation and Volksrust Formation. The Normandien Formation has several Members, namely the Harrismith at the top, Schoondraai, Rooinekke, and Frankfort at the base. As the study area is part of the Abrahamskraal Formation it will be part of the *Tapinocephalus* Assemblage Zone. Named after the dinocephalian genus *Tapinocephalus,* a representative of the subfamily Tapinocephalinae which is the most common group of dinocephalians in this stratigraphic interval. The bulk of the succession comprises alternating beds of drab grey siltstone and fine-grained greenish-grey sandstone with minor layers of maroon mudstone. The sandstone is of a greenish-grey fine-grained texture. The mudrock beds display structures such as oscillation ripples, wind induced wrinkle marks, falling water-level terraces, run-off rills, sand-filled desiccation cracks, fish trails and tetrapod trackways. Vegetation, dominantly of equisetalian type, was mainly confined to river banks during these semi-arid conditions. The type locality is at Prince Albert (Rubidge 1995).

Jurassic dolerite (Jd) is abundant. Dolerite is an igneous rock and therefore does not contain fossils. Dish-shaped dolerite structures are especially prominent (Cole *et al.* 2004).

Figure 2: The geology of the development area (Visser 1984).



Legend to Map and short explanation.

Pa – Mudstone, sandstone (green). Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Permian.

Pko – Sandstone, shale (brown). Koedoesberg Formation, Ecca Group, Karoo Supergroup. Permian.

Pk - Shale (light brown). Kookfontein Formation, Ecca Group, Karoo Supergroup. Permian.

Ps – Shale, sandstone (dark brown). Skoorsteenberg Formation, Ecca Group, Karoo Supergroup. Permian.

□ – Development (in black on the Figure).

↓ - Dip.

--f-- - Fault.

The Ecca Group 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).

Field Observation.

This property is large, quite overgrown with lush vegetation on top of a large hill. The presence of buildings and lush grass make it difficult to observe outcrops. Once the vegetation is cleared outcrops will be more visible.

Figure 4: Figure to show view on top of the hill. Large sandstone boulders can be seen.

Figure 5: Another view of the top of the hill, no mudrock is visible.

Figure 6: View towards side of hill. Also no mudrock outcrops.

Figure 7: Photograph to show side of hill and how overgrown the site is at present.

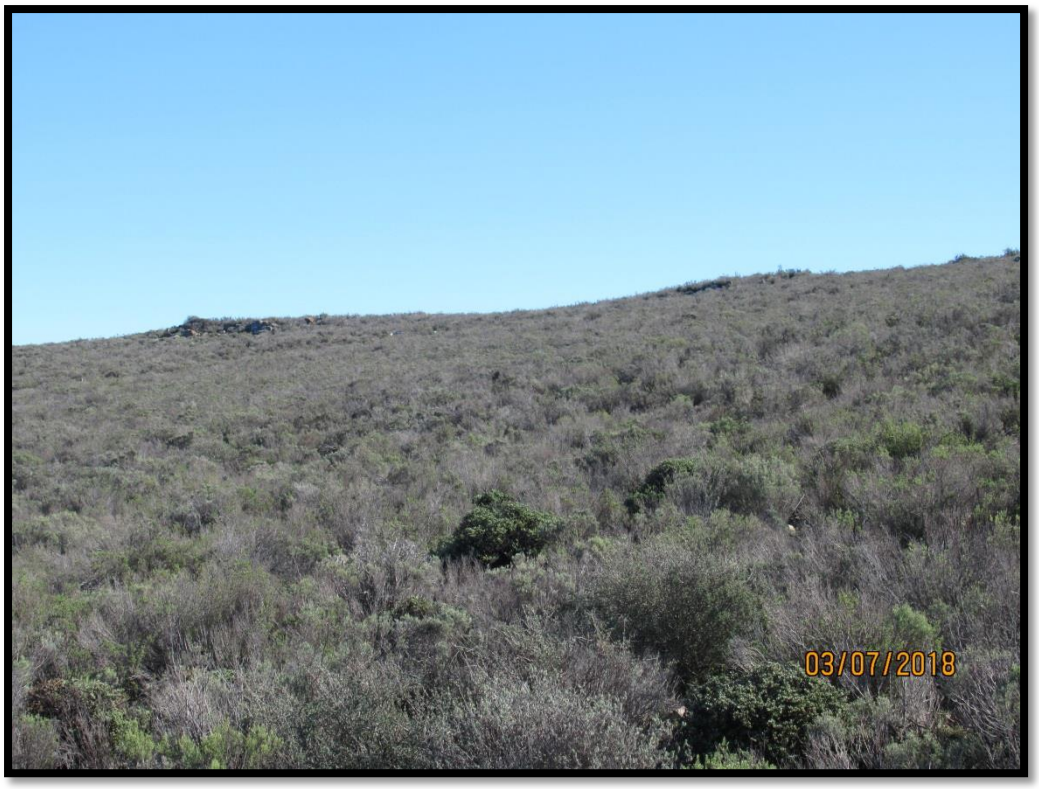


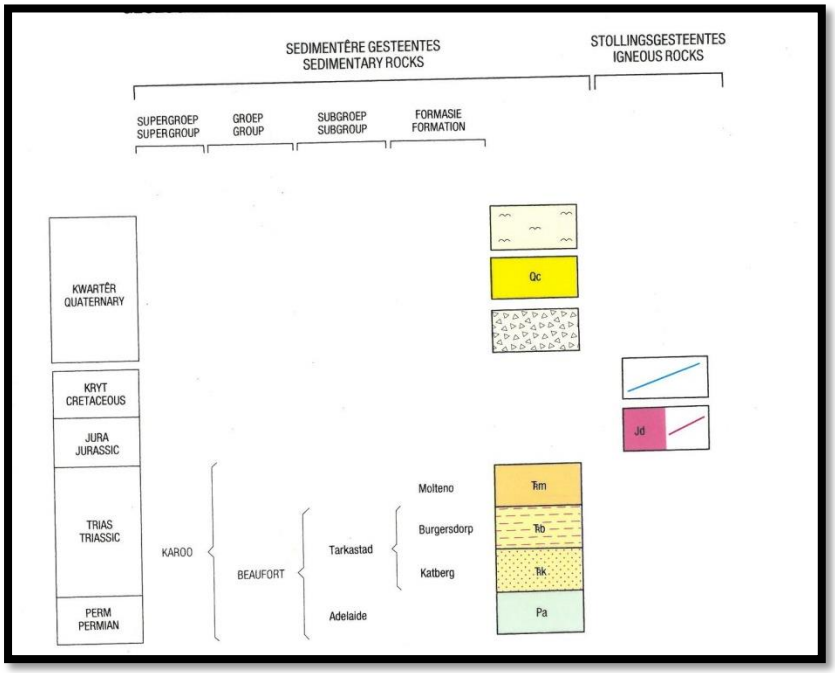
Figure 8: There are several dongas present at the bottom of the hill. None of them were fossiliferous.

Figure 9: There are several good outcrops present where the farm road is.

The Project includes one Alternative for the quarry. It is the Abrahamskraal sandstone and mudstone that will be mined.

It is assumed that fossil remains are not uniformely distributed in fossil bearing rock units. The affected Formation will be the Abrahamskraal Formation which is of a **VERY HIGH** Sensitivity.

Figure 8: Lithostratigraphic column of the geology of the site (3124 Middelburg).



It is recommended to wait for the response from SAHRA on the (this report) Phase 1: Field study. All the Alternatives for the power line will be partly over the Adelaide Subgroup and the Quaternary.

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).

Map 1: Biostratigraphic map of the Karoo Supergroup.

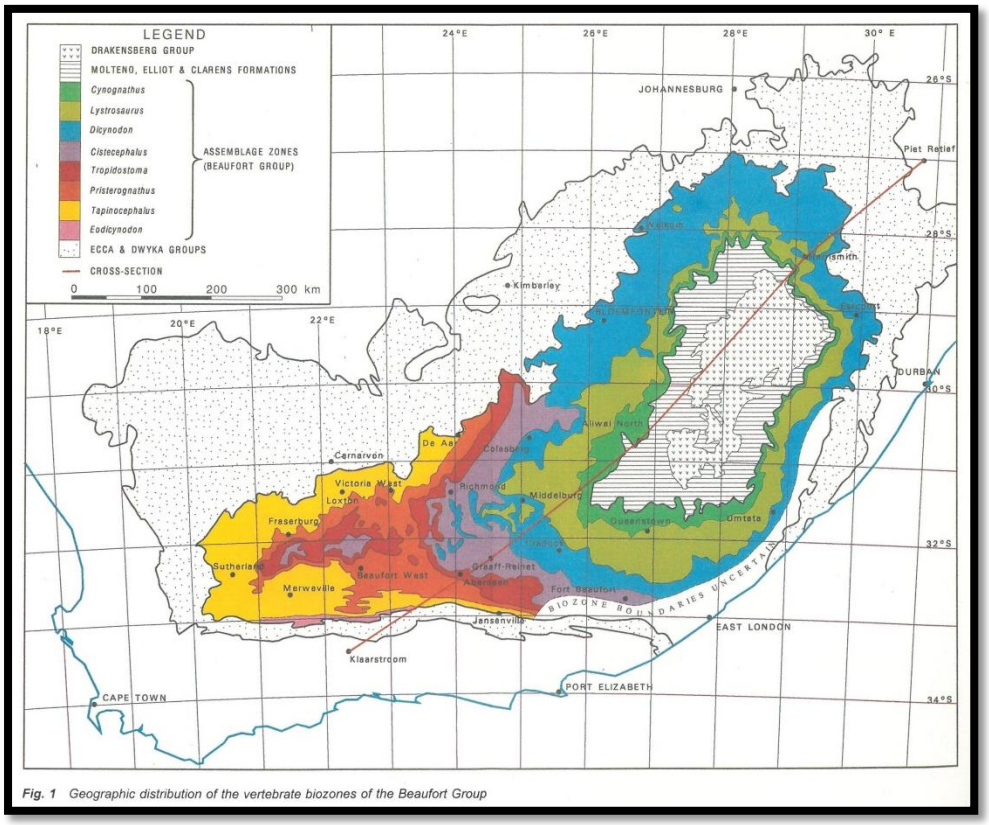


Fig. 1 Geographic distribution of the vertebrate biozones of the Beaufort Group

The *Tapinocephalus* Assemblage Zone (seen in yellow) overlies the *Eodicynodon* Assemblage zone and underlies the *Pristerognathus* Assemblage Zone. It spans the middle part of the Abrahamskraal Formation. The name is derived from a fairly common dinocephalian genus *Tapinocephalus* (Rubidge 1995).

Vertebrate fossils of this biozone are not generally as common as in the succeeding biozones. They are usually found as individual specimens in the mudrock sequences in association with, and often enveloped by, brown-weathering calcareous nodular material. *Bradysaurus* fossils often occur as complete articulated skeletons in a dorsal-up attitude whereas skulls of dinocephalians are rarely found with associated postcrania (Rubidge 1995).

Fossils common to the *Tapinocephalus* Assemblage zone are *Atherstonia* fish; amphibia such as *Rhinesuchus*; reptilia such as *Bradysaurus, Broomia* and *Eunotosaurus; Elliotsmithia* the Pelycosaur; Therapsids such as the dinocephalians *Anteosaurus, Jonkeria, Moscops, Struthiocephalus* and *Tapinocephalus;* dicynodonts such as *Diictodon, Emydops, Pristerodon,* and *Robertia; Hipposaurus* the Biarmosuchid; gorgonopsians such as *Aleurosaurus, Gorgonops, Galesuchus;* and the therocephalia *Alopecodon, Glanosuchus, Icticephalus* and *Lycosuchus.* It is not uncommon to find invertebrates, plant fossils and trace fossils.

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

Subgroup/	Group	Formation	Fossil Heritage	Comment

sequence				
Adelaide	Beaufort	Abrahamskraal	Diverse terrestrial and freshwater tetrapods, true reptiles, amphibia, synapsids, invertebrates, plants, fish, bivalves and trace fossils.	Pangaea fauna, mammalian evolution, late Permian mass extinction.

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).

Fossil localities in the area are abundant around Sutherland (Kitching 1977):- Elandsberg, Esperence, Komsberg, Kruisrivier and Roggekloof.

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 rock strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **VERY HIGH** for the Adelaide Subgroup, Karoo Supergroup.

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

Rock Unit	Significance/vulnerability	Recommended Action
Adelaide Subgroup	Very High	Field assessment and protocol for finds is required

Databases and collections: Ditsong: National Museum of Natural History.
Impact: **VERY HIGH** for the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. There are significant fossil resources that may be impacted by the development and if destroyed are no longer available for scientific research or other public good.

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in July of 2017. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images. The walk through of the affected portion was done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (Power Shot SX620HS). It was not necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to records outcrops where not covered with topsoil, subsoil, overburden, and vegetation.

Assumptions and Limitations (Appendix 6 of Act 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. 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. Field 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.
National Estate: 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: (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.

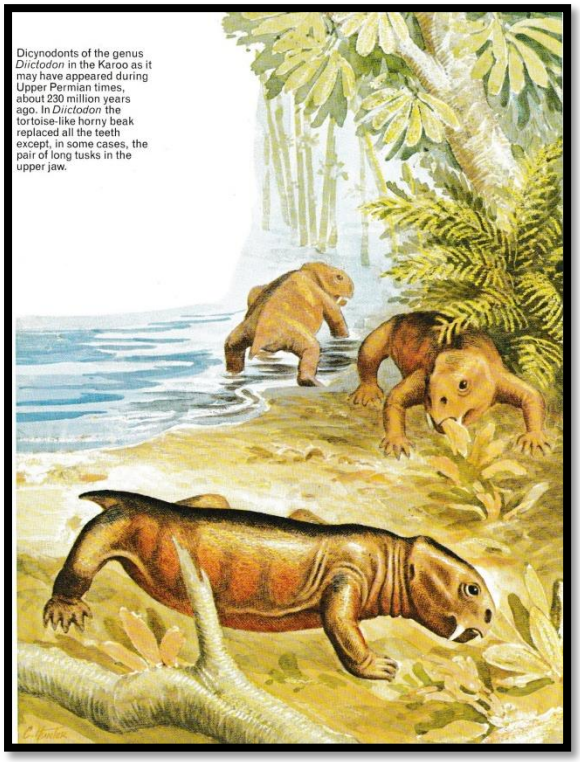
When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded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

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.

Figure 9: Typical Karoo scenes during the Late Permian (Cluver 1978).



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

The physical impact of the mining on the palaeontological heritage will be restricted to the structures erected and to the actual areas where mining will take place, the total impact on the National Heritage in terms of geological formations that provide unique rock units to the entire study area will be dramatic and irreversible. The Very High Sensitivity of the Adelaide Subgroup is retained (Groenewald 2016).

J. Recommendation (1j,1l)

a. There is no objection (see Recommendation B) to the development, and it is not necessary to request a Phase 2 Palaeontological Impact Assessment: Mitigation to determine whether the development will affect fossiliferous outcrops. The palaeontological sensitivity is **VERY HIGH** so caution is recommended. A Phase 2 Palaeontological Mitigation will be required if a fossil is found by the ECO during construction. Fossils were not found during the walk through.
b. This project may benefit the economy, the growth of the community, and social development in general.
c. Preferred choice: All Alternatives are possible. Care must be taken during the grading of roads, digging of foundations, drilling, and removing topsoil, subsoil and overburden (see Executive Summary) or blasting of bedrock.
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 and a palaeontologist should be called in to determine proper mitigation measures (see Recommendation in Section B).

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: **Yes,** if a fossil is found (Section G).
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 Field Study was provided by the Environmental Consultant.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed (see Recommendation B).
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 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 Geosciences.
CHINSAMY-TURAN, A. (ed) 2012. *Forerunners of Mammals.* Indiana University Press, Bloomington and Indiapolis. Pp 1-330.
CLUVER, M.A. 1978. *Fossil Reptiles of the South African Karoo.* South African Museum, Cape Town, Pp 54.
COLE, D.I., NEVELING, J. HATTINGH, J., CHEVALLIER, L.P., REDDERING J.S.V. and BENDER, P.A. 2004. Geology of the Middelburg Area. Explanation to sheet 3124, 1:250 000. Council for Geoscience, South Africa, Pp 43.
GROENEWALD, G. 2016. Palaeontological Desktop Assessment for the Proposed Application for Exploration Drilling by Rhino Oil and Gas Exploration South Africa (Pty) Ltd. Project ER 306, Northern Kwazulu-Natal Province.
GROENEWALD, G. and GROENEWALD, D. 2014. SAHRA Palaeotechnical Report: Palaeontological Heritage of the Northern Cape. South African Heritage Resources Agency, Pp 1-143.
JOHNSON, M.R. 2009. Ecca Group. Karoo Supergroup. Catalogue of South African Lithostratigraphic Units. SACS, **10:** 5-7.
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.
KITCHING, J.W.1977. The distribution of the Karoo Vertebrate Fauna. Memoir 1, Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Pp 131.
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.
MACRAY, C. 1999. *Life Etched in Stone: Fossils of South Africa.* The Geological Society of South Africa, Johannesburg, Pp 1-305.
NORMAN, N. 2013. *Geology off the beaten track: exploring South Africa's hidden treasures.* De Beers, Struik, Pp 1-256.
NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys.* De Beers, Struik, Pp 1-320.
SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.
ROSSOUW, L. 2017. Phase 1 Palaeontological Impact Assessment for the proposed Tetra 4 Cluster 1 Gas Production project near Virginia, Free State Province.
RUBIDGE, 1995 (Ed.). Biostratigraphy of the Beaufort Group (Karoo Supergroup), South African Committee for Stratigraphy, Biostratigraphic Series No. 1. Council for Geoscience, Pp 46.
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. (Ed) 1984. Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.
VISSER, D.J.L. (ed) 1989. *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, Pp 494.

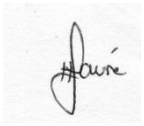
Declaration / Disclaimer (1b)

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 field study may have missed palaeontological resources in the Project Area as the presence of outcrops are not known and may only be found once development commences.

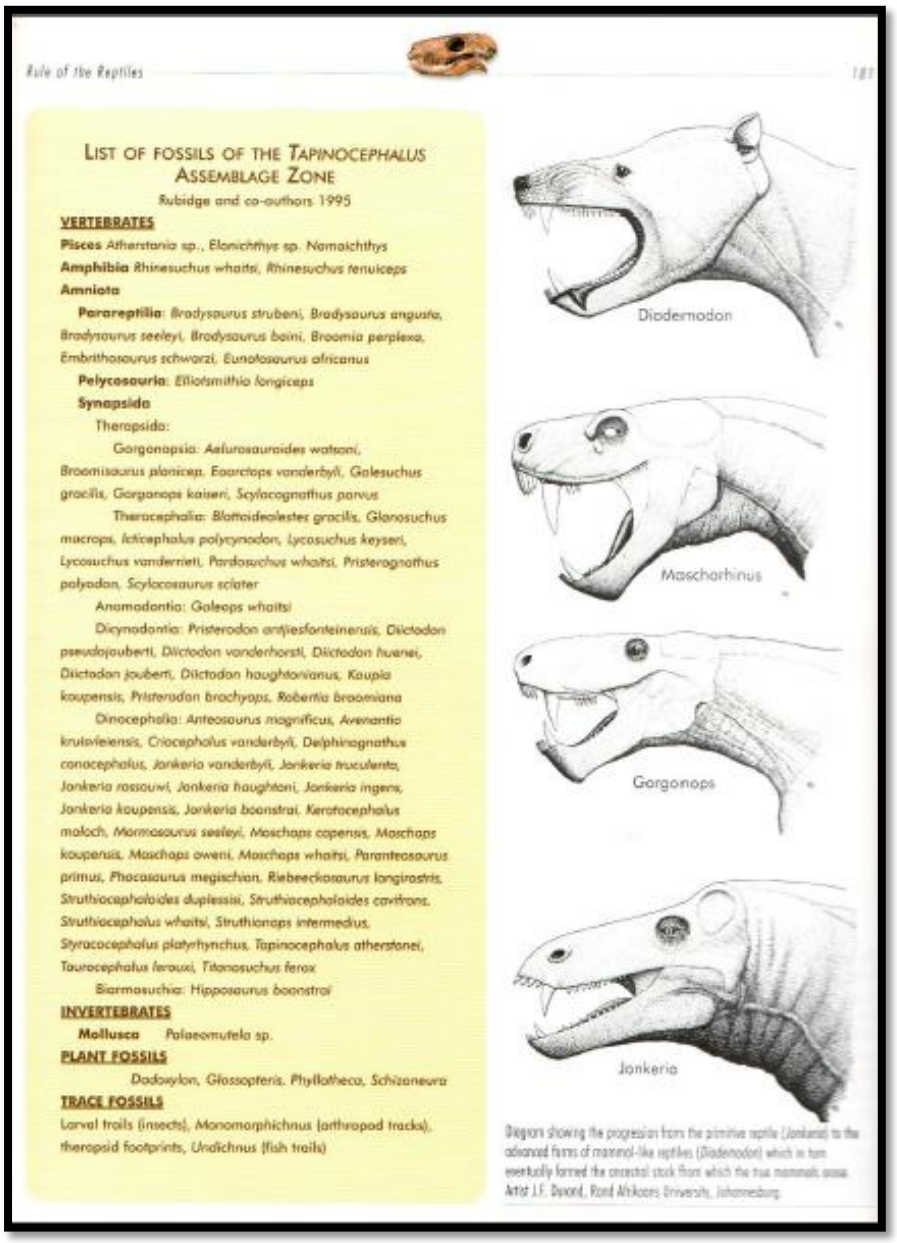
This report may not be altered in any way and any parts drawn from this report must make reference to this report.



_____

Heidi Fourie
2018/07/18

Appendix 1: Summary of *Tapinocephalus* Assemblage Zone (McCrae 1999).



Appendix 2:

Table 3: 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 1	1(k)	Protocol for finds
	1(m)	"
	1(q)	"

Appendix 3: 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 needs to 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. This ECO should familiarise him- or herself with the applicable formations and its fossils. Miners or 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. A palaeontologist should be employed once a month during the construction phase of the Plant to inspect the site.

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; see Report, or any other fossiliferous layer ranked as **VERY HIGH or HIGH**.
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work. The area needs to be fenced off.
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, 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 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 / ECO 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. 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.