Upgrading of Qumza Highway Phase 7

Buffalo City Metropolitan Municipality, Amathole District Municipality, Eastern Cape Province

Farm: Road is within an established urban road reserve

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Palaeontological Impact Assessment: Phase 1 Field study

Facilitated by: Royal HaskoningDHV

P.O. Box 15261, Beacon Bay, EC, 5241

Tel: 043 707 3000

2016/08/26

Ref: Pending

B. Executive summary

Outline of the development project: Royal HaskoningDHV has facilitated the appointed of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field study of the suitability of the upgrading of the Qumza Highway Phase 7 in the Buffalo City Metropolitan Municipality, Amathole District Municipality, in the Eastern Cape Province.

The applicant, Buffalo City Metropolitan Municipality, proposes to upgrade the Qumza Highway Phase 7 to prevent flooding and facilitate increased traffic flow and safety of vehicles and pedestrians.

The Project includes one Option (see map):
Option 1: An area outlined in red following the curvature of the highway with the four marked drainage culverts. The upgrade totals 4.21 km. between Jiba Road and the Golden Highway.

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) and 3226 King Williams Town, 1:250 000 geological map (Johnson 1976).

Figure 3: The geology of the development area.

Legend to Map and short explanation.
Pub – Grey mudstone, shale, sandstone (green) – Balfour Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.
Pum – Grey and 'red' mudstone, sandstone (green) – Middleton Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.
Jd – Dolerite, Karoo Dolerite suite (dark brown).
…… – (black) Lineament (Possible dyke).
--f— Fault.
⊥10˚ - Strike and dip.

Summary of findings: The Phase 1 Palaeontological Impact Assessment Field study was undertaken in August in the winter in dry and cold conditions, and the following is reported:

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989) (Figure 3). 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. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top of the Stormberg Group is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts (Kent 1980, Snyman 1996).

The Adelaide Subgroup consists of up to three formations (Koonap, Middleton, Balfour). Mudrock predominates with subordinate sandstone and is Upper Permian in age. It overlies the Ecca Group conformably and is overlain by the Katberg Formation of the Tarkastad Subgroup. Siltstone beds are common (Cole *et al.* 2004). The Balfour Formation is distinguished from the Middleton Formation by the lack of 'red' mudstone and is ±2150 m. thick, whereas the Middleton Formation is ±1600 m. thick (sheet info, Kent 1980). The Abrahamskraal and Teekloof Formations also form part of the Adelaide Subgroup (Snyman 1996). Chert is present in the Abrahamskraal Formation. The Adelaide Subgroup has a maximum thickness of 1750 m. in the south (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 **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 may be necessary for this development (according to SAHRA protocol). A Phase 2 Palaeontological Impact Assessment and or mitigation may be recommended. The overburden and inter-burden consisting of Karoo rocks must be surveyed for fossiliferous outcrops (mudstone, shale). Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers. Protocol is attached (Appendix 1) (See Section E) with recommendations for the management of the road during construction.

During the survey it was found that the site is directly underlain by siltstone, sandstone, and mudstone of the Karoo Supergroup and is presently utilised as a road with a side-walk. Recent structures are present such as bridges, as well as houses, power lines and a petrol station. The site is located on a sloping topography with rocky outcrops (bedrock). The development of the road includes several projects that will need channels and trenches (storm water) to be dug and removal of overburden and vegetation. Large sections of the road are present on sandstone.

The survey was done in winter, conditions were dry and cold with a little bit of rain. The area is covered by overburden, vegetation and grass. Formations present are the Karoo Supergroup Formations more specifically the Middleton and Balfour of the Beaufort Group (Adelaide Subgroup) known for its wealth of fossils. Mudstone was found in one place. The mitigation process should take place before upgrading of the road starts. Further impact is anticipated during road maintenance.

The Project includes one Option (see map):
Option 1: An area outlined in red following the curvature of the highway with the four marked drainage culverts. The upgrade totals 4.21 km. between Jiba Road and the Golden Highway.

Concerns/threats:

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic and human disturbance.
2. Mitigation is needed (Appendix 1).
3. No consultation with parties was necessary.

Stakeholders: Developer – Buffalo City Metropolitan Municipality, 26 Oxford Street Planning and Engineering Building, 2nd Floor East London, 5201.
Environmental – Royal HaskoningDHV, P.O. Box 15261, Beacon Bay,EC, 5241, 043 707 3000.
Landowner – Buffalo City Metropolitan Municipality.

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

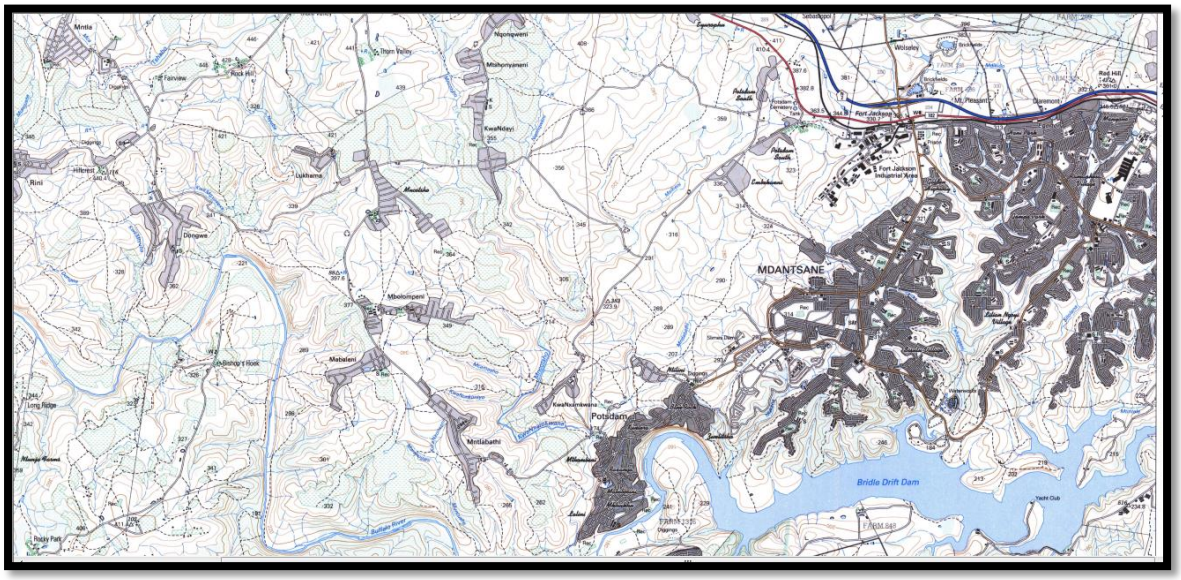
This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it is necessary for the developer to apply for the relevant permit from the South African Heritage Resources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

The road is an existing 6.8 m. wide road with existing cross culverts that need to be replaced due to their current condition to prevent further flooding of the road at the four crossings. The existing carriageway is to be widened from nominally 6,8 m. to 14 m.with two traffic lanes in each direction. No locality or design alternatives need to be assessed. The following road infrastructure is anticipated:

1. 4 Culverts,
2. Power lines,
3. Pavement, and
4. Road.

The recommendation is to use concrete pavement, concrete block pavement, concrete strips. Water crossings will be constructed with new concrete barrel box culverts.

Figure 1: Topographic map showing Mdantsane, 3227 DC 1996 (Royal HaskoningDHV)



The Project includes one Option (see map):

Option 1: An area outlined in red following the curvature of the highway with the four marked drainage culverts. The upgrade totals 4.21 km. between Jiba Road and the Golden Highway.

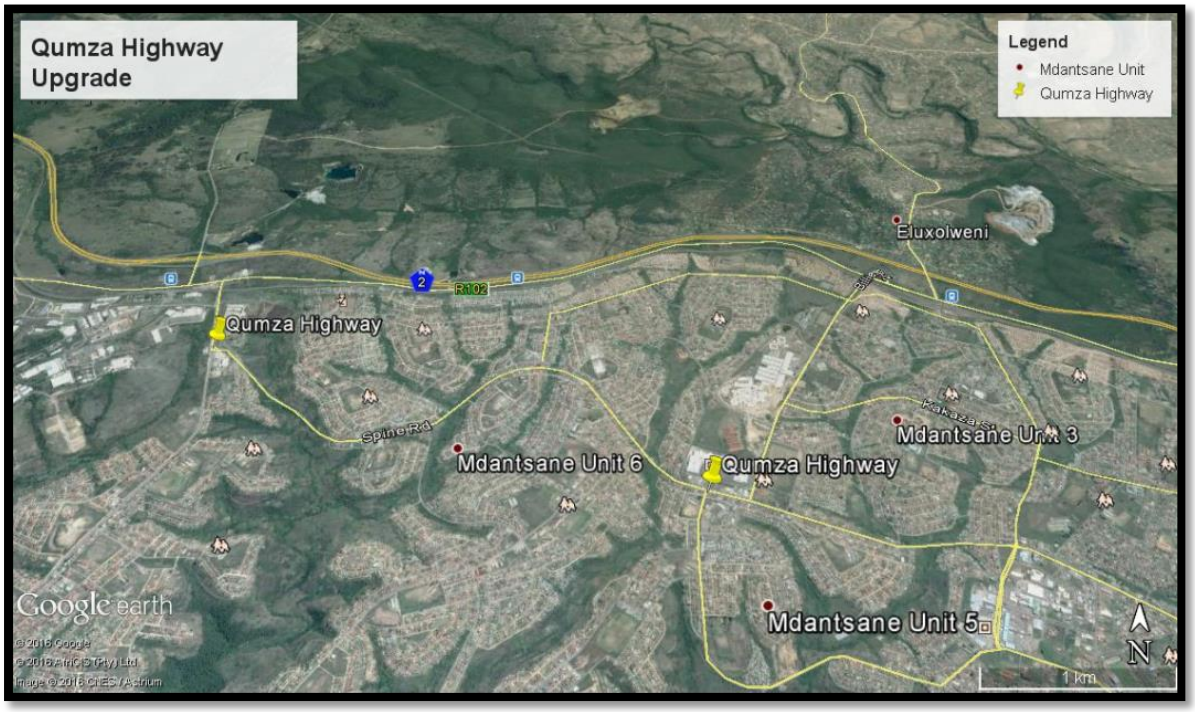
Rezoning/ and or subdivision of land: No.

Name of Developer and Consultant: Buffalo City Metropolitan Municipality and Royal HaskoningDHV.
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 twelve years she carried out field work in the Eastern Cape, Limpopo, Mpumalanga, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 22 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 project includes the upgrading of the Qumza Highway Phase 7 between Jiba Road and the Golden Highway in the Buffalo City Metropolitan Municipality, Amathole District Municipality, in the Eastern Cape Province.

The Project includes one Option (see map):
Option 1: An area outlined in red following the curvature of the highway with the four marked drainage culverts. The upgrade totals 4.21 km. between Jiba Road and the Golden Highway.

Figure 2: Google.earth image showing location of border road (Royal HaskoningDHV).



The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grass, rocky outcrops, the road and side-walk.

F. Description of the Geological Setting
Description of the rock units:
Large areas of the southern African continent are covered by the Karoo Supergroup (Figures 4, 5, Map 1). It covers older geological formations with an almost horizontal blanket. Several basins are present with the main basin in the central part of south Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. 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. The Elliot Formation is also known as the Red Beds and the old Cave

Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent 1980, Snyman 1996).

The Tarkastad Subgroup of the Beaufort Group consists of a lower predominantly arenaceous Katberg Sandstone Formation and a predominantly upper argillaceous Burgersdorp Formation (Cole *et al*. 2004, Kent 1980). It is Early Triassic in age. This Subgroup is absent in the west of the basin. A maximum thickness of 900 m can be measured for the Katberg sandstone. Red, bluish and green mudstone, siltstone and fine- to medium-grained sandstone lenses are characteristic of the Burgersdorp Formation. This Subgroup marks the boundary of the Palaeozoic and the Mesozoic (Snyman 1996, Visser 1998). Fossil mammal-like reptiles are present (Norman and Whitfield 2006).

Figure 3: Geology of the development area.

Legend to Map and short explanation.

Pub – Grey mudstone, shale, sandstone (green) – Balfour Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.

Pum – Grey and 'red' mudstone, sandstone (green) – Middleton Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.

Jd – Karoo Dolerite suite (dark brown).

…… – (black) Lineament (Possible dyke).

--f— Fault.

⊥10˚ - Strike and dip.

Q – Approximate position of Highway upgrade.

The rocks of the Beaufort Group were deposited by large, northward-flowing, meandering rivers in which sand accumulated, flanked by extensive floodplains where periodic floods deposited mud. Following the end-Permian mass extinction, the meandering rivers were replaced by multi-channelled, braided river systems that deposited sand rather than the silts and muds of the earlier meandering rivers. The sandstone-dominated strata deposited by these braided rivers, known as the Katberg Formation, can be as much as 1000 m. thick. As time passed, the high-energy, braided rivers of the Katberg Formation reverted to a meandering form, possibly reflecting recovery of the vegetation. These sedimentary deposits are the Burgersdorp Formation (McCarthy and Rubidge 2005).

The Adelaide Subgroup consists of up to three formations (Koonap, Middleton, Balfour). Mudrock predominates with subordinate sandstone and is Upper Permian in age. It overlies the Ecca Group conformably and is overlain by the Katberg Formation of the Tarkastad Subgroup. Siltstone beds are common (Cole *et al.* 2004). The Balfour Formation is distinguished from the Middleton Formation by the lack of 'red' mudstone and is ±2150 m. thick, whereas the Middleton Formation is ±1600 m. thick (sheet info, Kent 1980). The Abrahamskraal and Teekloof Formations also form part of the Adelaide Subgroup (Snyman 1996). Chert is present in the Abrahamskraal Formation. The Adelaide Subgroup has a maximum thickness of 1750 m. in the south (Visser 1989).

A short period of uplift and erosion followed. This was short-lived, however, and sedimentation was renewed, forming the rocks of the Stormberg Group on top of the slightly eroded rocks. The rocks of the Stormberg Group reflect a gradual change to increasingly more arid conditions. The Molteno Formation rocks were deposited mainly by large braided rivers. A change in climate is reflected in the floodplain sediments of the Elliot Formation. In addition to meandering river deposits, salt-pan deposits are found, containing fossilised lungfish, as well as fossilised, thick, arid-zone soil layers. Warming and aridity increased towards the end of the deposition of the Elliot Formation. By the time of deposition of the rocks of the upper Clarens Formation, true desert conditions prevailed, with the development of an extensive sand sea (McCarthy and Rubidge 2005).

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. Zones present in the study area are the *Tropidostoma* Assemblage Zone, the *Cistecephalus* Assemblage Zone and the *Dicynodon* Assemblage Zone including the Teekloof Formation, the upper part of the Middleton Formation and the Balfour Formation, and is characterised by the abundance of *Tropidostoma* in association with *Endothiodon, Pristerodon* and *Diictodon; Cistecephalus, Aulacephalodon* and *Oudenodon; Dicynodon* and *Theriognathus* (Rubidge 1995). Plant fossils such as *Glossopteris* and silicified wood are also present (sheet info).

Figure 4: Geographic distribution of the vertebrate biozones of the Beaufort Group.

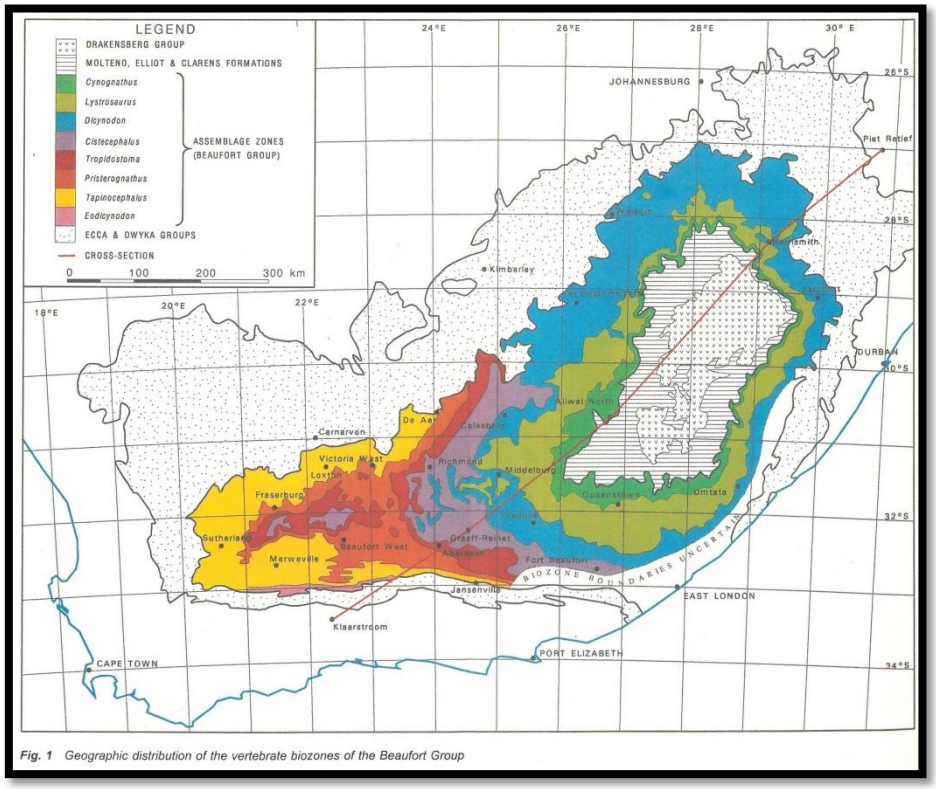
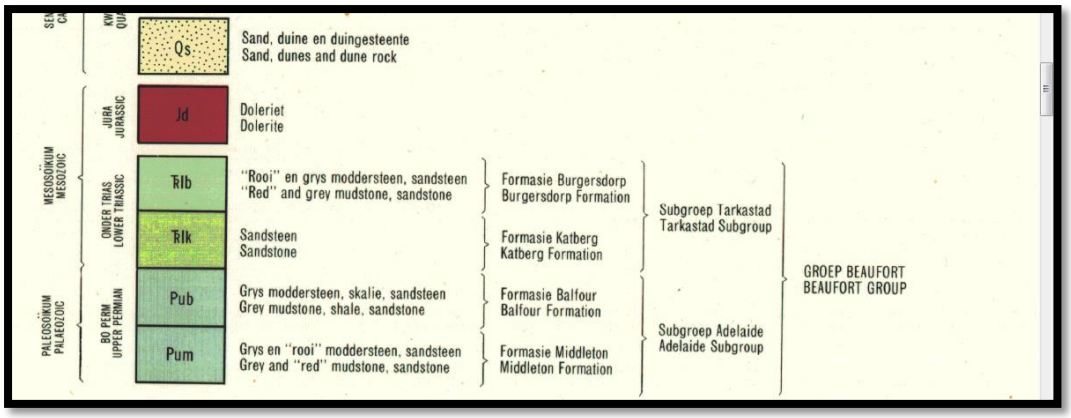


Fig. 1 Geographic distribution of the vertebrate biozones of the Beaufort Group

The Project includes one Option (see map):
Option 1: An area outlined in red following the curvature of the highway with the four marked drainage culverts. The upgrade totals 4.21 km. between Jiba Road and the Golden Highway.

Figure 5: Lithostratigraphic column of the Karoo Supergroup (Johnson 1976).



Dolerite dykes (Jd) 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.

The survey was done in August 2016, conditions were dry, cold and windy. It was possible to survey the entire road surface. Photographs below show the sloping topography. A variety of soil types (overburden and topsoil) with mudstone and sandstone banks are present (Figures 6-11).

Field Observations.

Figure 6: The road and its shoulder are currently well maintained, grass, vegetation, topsoil and overburden are present next to the side-walk. Sandstone outcrops are present. View towards beginning of study area and culvert 4.

Figure 7: View to show embankment (sandstone) and road, view towards the west. Position of culvert 4.

Figure 8: Example of a mudstone found near petrol filling station and beginning of road upgrade (S 28˚21'645", E 28˚22'985"). This type of outcrop will need mitigation as it is right on the shoulder of the road.

Figure 9: View to the east with embankment covered in grass showing topography.

Figure 10: Road with shoulder covered in grass. View to the west. Position of culvert 3.

Figure 11: Road and shoulder to the east. View towards culvert 2.

Figure 12: Road and shoulder to the east, sandstone is visible.

Figure 13: Road and shoulder to the east. View towards culvert 1.

Figure 14: East view on pavement at 4.2 km.

Figure 15: View at 4.2 km at end of upgrade. The boulders on the pavement are sandstones.

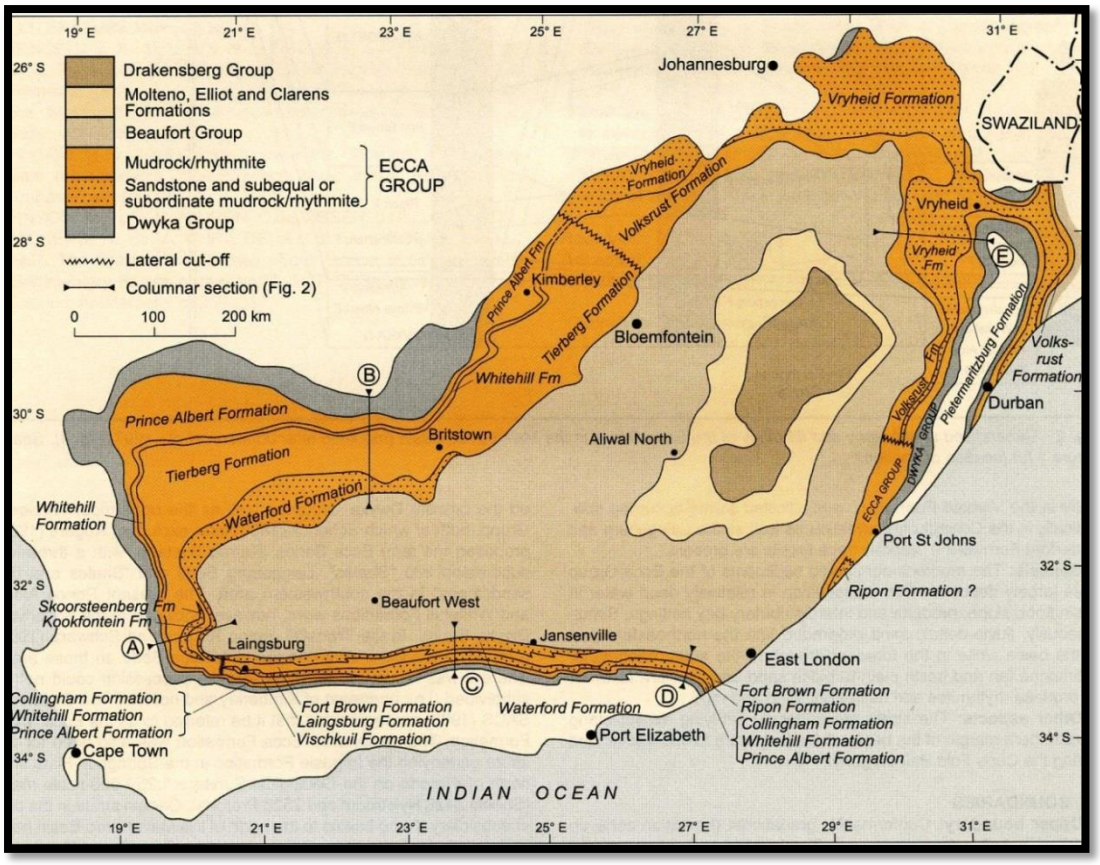
The geological formations consist mainly of flat-lying sandstones, shales and subsidiary siltstones and mudstones. The survey did not find any fossils. Most of the site is directly underlain by stratigraphic units belonging to the upper Permian of the Karoo Supergroup. It may be possible that the grading of the road will intrude into the fossiliferous sandstone, mudstone, siltstone or shale. There is some concern with the property due to the presence of the Karoo Supergroup. The depth of the Formation can be verified with geological cores. The outcrops, topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the fossiliferous layers. Bedrock exposure is very good and most of the road surface is on sandstone.

It is recommended to wait for the response from SAHRA on the Phase 1 Field study (this report), and if mitigation is recommended then SAHRA protocol must be followed. Alternatives will not be feasible as all proposed development portions and surrounding areas are on the Karoo Supergroup.

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: Extent of the Karoo Supergroup (Johnson 2009).

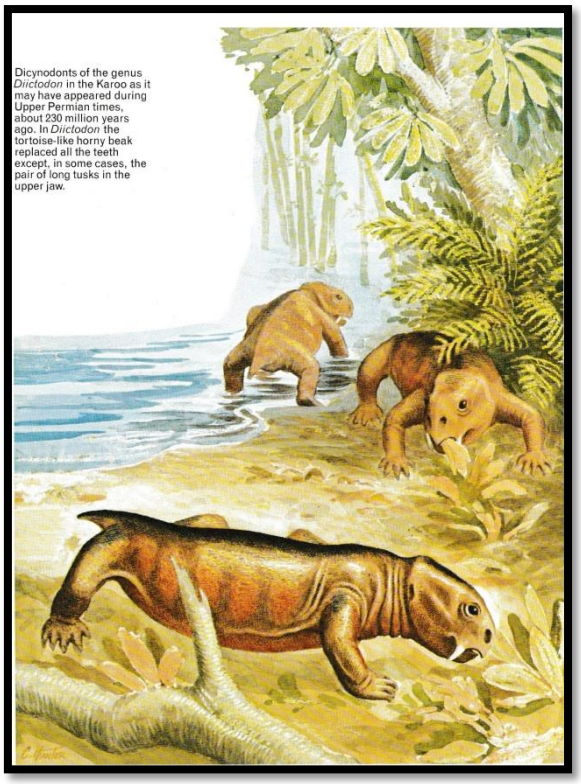


The rocks of the Karoo Supergroup are internationally acclaimed for their richness and diversity of fossils. The rocks of the Beaufort Group of South Africa cover approximately one-third of the land surface and have yielded an abundance of well-preserved therapsids and other tetrapods which have been used to subdivide this Group into eight faunal Assemblage Zones.

Fossil vertebrates are found in the thick mudrock. Fossils of *Diictodon, Ictidosuchops, Gorgonops* and the amphibian *Rhinesuchus* are frequently preserved as articulated skeletons within the mudrock present in the *Tropidostoma* Assemblage Zone (Figure 16). Fossil fish (*Atherstonia*) and the captorhinid *Pareiasaurus* have also been recorded. The *Cistecephalus* Assemblage Zone is characterised by the presence of *Cistecephalus, Ictidosuchoides* and *Rubidgea.* Fossil fishes, invertebrates, plants and trace fossils also occur in both biozones. The *Dicynodon* Assemblage Zone is characterised by *Procynosuchus, Tetracynodon, Lycaenops, Ictidorhinus, Dicynodon, Youngina, Rhinesuchus* and *Atherstonia* to name but a few (Rubidge 1995).

Rubidge (1995) listed the uppermost part of the Middleton Formation as occurring in the *Cistecephalus* Assemblage Zone. The dispersed isolated fossils are preserved in the interchannel mudrocks. Small dicynodonts are abundant. The small procolophonid *Owenetta* makes its first appearance in this zone but is very scarce.

Figure 16: Typical Karoo scene during the Upper Permian times (Cluver 1978).



A high diversity of sauropod dinosaur fauna of the Lower Cretaceous Kirkwood Formation is present in the Port Elizabeth area. Dinosaurs such as *Algoasaurus bauri, Astrodon* and *Pleurocoelus* have been described (McPhee *et al.* 2016).

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 **VERY HIGH** for the Adelaide Subgroup.

Table 1: 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
Beaufort Group	Very High	Field assessment and protocol for finds is required

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: **VERY HIGH** for the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. There are significant fossil resources that may be impacted by the development (mudstone, shale) and if destroyed are no longer available for scientific research or other public good (Almond, *et al.* 2009).

H. Description of the Methodology

The palaeontological impact assessment field study was undertaken in August 2016. The survey of the affected portion was done and photographs (in 7.1 mega pixels) were taken of the site with a digital Canon camera (PowerShot A470). Additionally Google.maps was accessed on a Sony Experia cellular phone. A Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds and outcrops (bedrock) when the area is not covered with topsoil, subsoil, overburden, vegetation, grassland, trees or waste. The survey did identify the Karoo Supergroup. A literature survey is included and the study relied heavily on geological maps.

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 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

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **VERY HIGH** for the Adelaide Subgroup.

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 (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation

a. There is no objection (see Recommendation B) to the development, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is **VERY HIGH**. A Phase 2 Palaeontological Mitigation may be required as the Phase 1 Palaeontological Assessment identified a fossiliferous formation (Karoo Supergroup). Protocol is attached (Appendix 2).
b. This project may benefit the economy, the safety of the community, the growth of the community and social development in general as well as curb the flooding.
c. Preferred choice: The impact on the palaeontological heritage is **VERY HIGH.** The presence of Karoo Formations is problematic. Care must be taken during the grading of the road, digging of foundations 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 clearing, 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.

Sampling and collecting:
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.
d. Permits for mitigation: **Needed from SAHRA/PHRA prior to Mitigation**.

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 Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was provided by Royal HaskoningDHV.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures. Especially 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.

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Declaration

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.

Heidi Fourie accepts no liability, and the client, by receiving this document, indemnifies Heidi Fourie 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.

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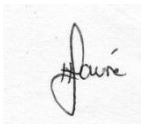

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Heidi Fourie
2016/08/26

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 on site and should not be attempted by the layman / developer.

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.

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).

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. When the route is better defined, it is recommended that a specialist undertake a 'walk through' of the entire road as well as construction areas, including camps and access roads, prior to the start of any construction activities, this may be done in sections.
2. Fossils likely to occur are for example the therapsids from the Middleton Formation, these are present in the mudstone (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or other vertebrates from the Beaufort Group (or any other fossiliferous layer). The palaeontologist needs to survey the overburden, subsoil and topsoil at least once a week.
3. When clearing vegetation, topsoil, subsoil or overburden, hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once every week).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. 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.

This document forms part of the Environmental Monitoring Programme. For practical reasons a palaeontologist/palaeobotanist may be required to be on site once a week. If any fossil material is discovered then a Phase 2 rescue operation may be necessary, and a permit will be required.

The South African Heritage Resources Agency has the following documents in place:
Guidelines to Palaeontological Permitting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports (Eastern Cape, North West, Northern Cape, Mpumalanga, Gauteng, Western Cape, Free State, Kwazulu Natal, and Limpopo)

Appendix 2:
Table 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 1	1(k)	Protocol for finds
	1(m)	"
	1(q)	"