Basic Assessment and Water Use Authorisation Process for the Proposed Upgrade of National Road R573 Section 1 (Moloto Road), Gauteng Province, Part 1: R573 From Baviaanspoort Road (M15) to Stormvoël Road (M5) and Moepel Road Overpass

City of Tshwane Metropolitan Municipality, Gauteng Province

Farm: Hartbeestpoort 328-JR, Silvertondale, Jan Niemandpark, Derdepoort 326-JR, Wolmaranspoort Agricultural Holdings, and Derdepoortpark.

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012 322 7632/079 940 6048

Palaeontological Impact Assessment: Desktop Study

Commissioned by: GA Environment

90 Bekker Road,

Midrand,

1686

011 312 2537

Ref: Pending

2020/06/18

B. Executive summary

Outline of the development project: GA Environment has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Desktop Study of the Basic Assessment and Water Use Authorisation Process for the Proposed Upgrade of National Road R573 Section 1 (Moloto Road), Gauteng Province, Part 1: R573 From Baviaanspoort Road (M15) to Stormvoël Road (M5) and Moepel Road Overpass in the City of Tshwane Metropolitan Municipality, Gauteng Province on the Farms Hartbeestpoort 328-JR, Silvertondale, Jan Niemandpark, Derdepoort 326-JR, Wolmaranspoort Agricultural Holdings, and Derdepoortpark.

The applicant, SANRAL SOC Limited plans to construct a new road between Stormvoël Road and Baviaanspoort Road including the extension of Baviaanspoort Road to link with the urban streets to the east of the R573-1, and construction of the Moepel Road Overpass across the R513, Sefako Makgatho Drive.

The Project includes four Alternatives (Figure 2):
Preferred: Prelim Design - crosses the riparian area at three sections (red).
Alternative 1: Crosses the riparian area of the Moreleta Spruit at two sections (blue).
Alternative 2: Follow a completely different route to the east (purple).
Alternative 3: This route is further removed from the residential areas and the schools (lime).
The area is approximately 2.3 kilometres in length with the Moepel Overpass at 700 km.

Legal requirements:-

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

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

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

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

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

(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999). Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report (**1c)** aims to provide comment and recommendations on the potential impacts that the proposed development project / mining (if applicable) could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:
The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 1:250 000, 2528 Pretoria (Walraven 1978).

Figure 3: The geology of the development area.

Legend to map and short explanation.
M – Alluvium (yellow). Quaternary.
di – Diabase (green). Vaalian to post Mockolian.
Vsi – Shale, carbonaceous in places; hornfels; chert (brown). Silverton Formation, Pretoria Group, Transvaal Supergroup. Vaalian.
------ – (black) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
⊥36 – Strike and dip of bed.
□ – Proposed development (blocked in black).

The quaternary alluvium is present in the north, but it has a very small footprint.

The Silverton shale Formation is rich in carbon and pyrite and show cross-bedding. Brown to khaki-weathering shales is stratigraphically below the Magaliesberg Formation. These shales are visible in road cuttings. The Silverton shale Formation is the thickest of all the shale formations of the Pretoria Group (300-3000 m). It forms wide valleys and when changed to hornfels can be used for roof coverings (Visser 1989). The pile of sedimentary rocks, mainly mudstones and quartzites with some basalt can collectively reach a thickness of up to 5 km.

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

One of the formations in the development area may contain fossils. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

Chemical sediments such as fine-grained limestone (chert) and dolomite is made up of deposits of organically derived carbonate shells, particles or precipitate. Dolomite is magnesium-rich limestone formed from algal beds and stromatolites. These Early Proterozoic Transvaal stromatolitic dolomites formed and released free oxygen at around 2900 – 2400 Ma. Stromatolites are common in the dolomites, accepted to be the fossil remnants of the simplest single-celled organisms. They are finely layered, concentric, mound-like structures formed by microscopic algal organisms (Norman and Whitfield 2006). Chert may contain fossils such as echinoids or sponges if nodular, although not common and is rated unlikely.

Summary of findings (**1d**): The Desktop Palaeontological Impact Assessment was undertaken in June 2020 in the winter in mild and dry conditions (**1c)** during the official covid-19 lockdown, as this is a desktop study the season and time has no influence and the following is reported:

The Project includes four Alternatives (Figure 2):
Preferred: Prelim Design - crosses the riparian area at three sections (red).
Alternative 1: Crosses the riparian area of the Moreleta Spruit at two sections (blue).
Alternative 2: Follow a completely different route to the east (purple).
Alternative 3: This route is further removed from the residential areas and the schools (lime).
The area is approximately 2.3 kilometres in length with the Moepel Overpass at 700 km.

The four Alternatives presented is situated on the Silverton Formation. All Alternatives in the area will be situated on the same rocks.

Recommendation:
The potential impact of the development on fossil heritage is **HIGH** for the Silverton Formation and **MODERATE** for the Pretoria [and **LOW** for the alluvium] and therefore a field survey will be necessary for this development (according to SAHRA protocol) if fossils are found during construction. A Phase 2 PIA and or mitigation are generally only recommended if the Phase 1: Field Study finds fossils or fossils are found during construction excavations and blasting (plants).

Concerns/threats (**1g**) to be added to the EMPr:

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

The recommendations are (**1ni, 1niA,1nii)**:

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

Stakeholders: Developer – SANRAL SOC Limited.
Environmental – GA Environment, 90 Bekker Road, Midrand, 1686, Tel. 011 312 2537.
Landowner – Several.

C. Table of Contents

D. Background information on the project

<u>Report</u>

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 (May 2019) of the Environmental Impact Assessment Regulations (see Appendix 2). It is also in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports (**2**), SAHRA, APMHOB, Guidelines 2012, Pp 1-15.

<u>Outline of development</u>

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

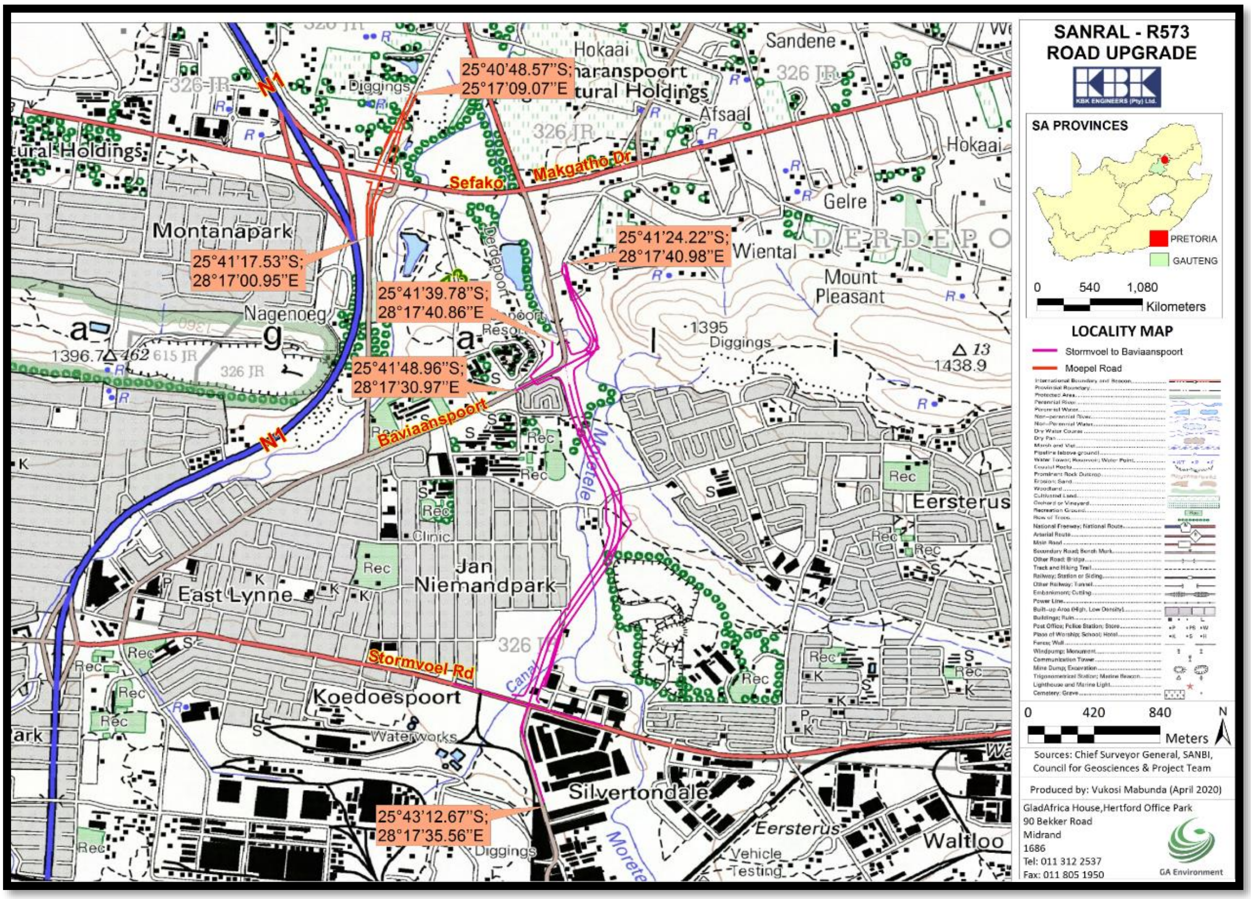
The applicant, SANRAL plans to construct a new road between Stormvoël Road and Baviaanspoort Road including the extension of Baviaanspoort Road to link with the urban streets to the east of the R573-1, and construction of the Moepel Road Overpass across the R513, Sefako Makgatho Drive. The new road will accommodate the increased traffic, reduce congestion and improve safety.

The Project includes the following related infrastructure (**1f)**:

- Road shoulder.
- Culverts.
- Dual carriageway.
- Road reserve of 80 m.
- Overpass of 700 m at 30-80 m wide.

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

Figure 1: Topographic map (GA Environment)



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Alternative 3: This route is further removed from the residential areas and the schools (lime).

The area is approximately 2.3 kilometres in length with the Moepel Overpass at 700 km.

Rezoning/ and or subdivision of land: No.

Name of developer and Environmental consultant: SANRAL SOC Limited and GA Environment.

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.

Curriculum vitae – short (**1aii, 1aii**): Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. She is currently employed by Ditsong: National Museum of Natural History as Curator of the fossil plant, invertebrate, amphibian, fish, reptile, dinosaur and Therapsid collections. For the past 13 years she carried out field work in the Eastern Cape, Western Cape, North West, Northern Cape, Free State, Gauteng, Limpopo, Kwazulu Natal, and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 25 years.

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

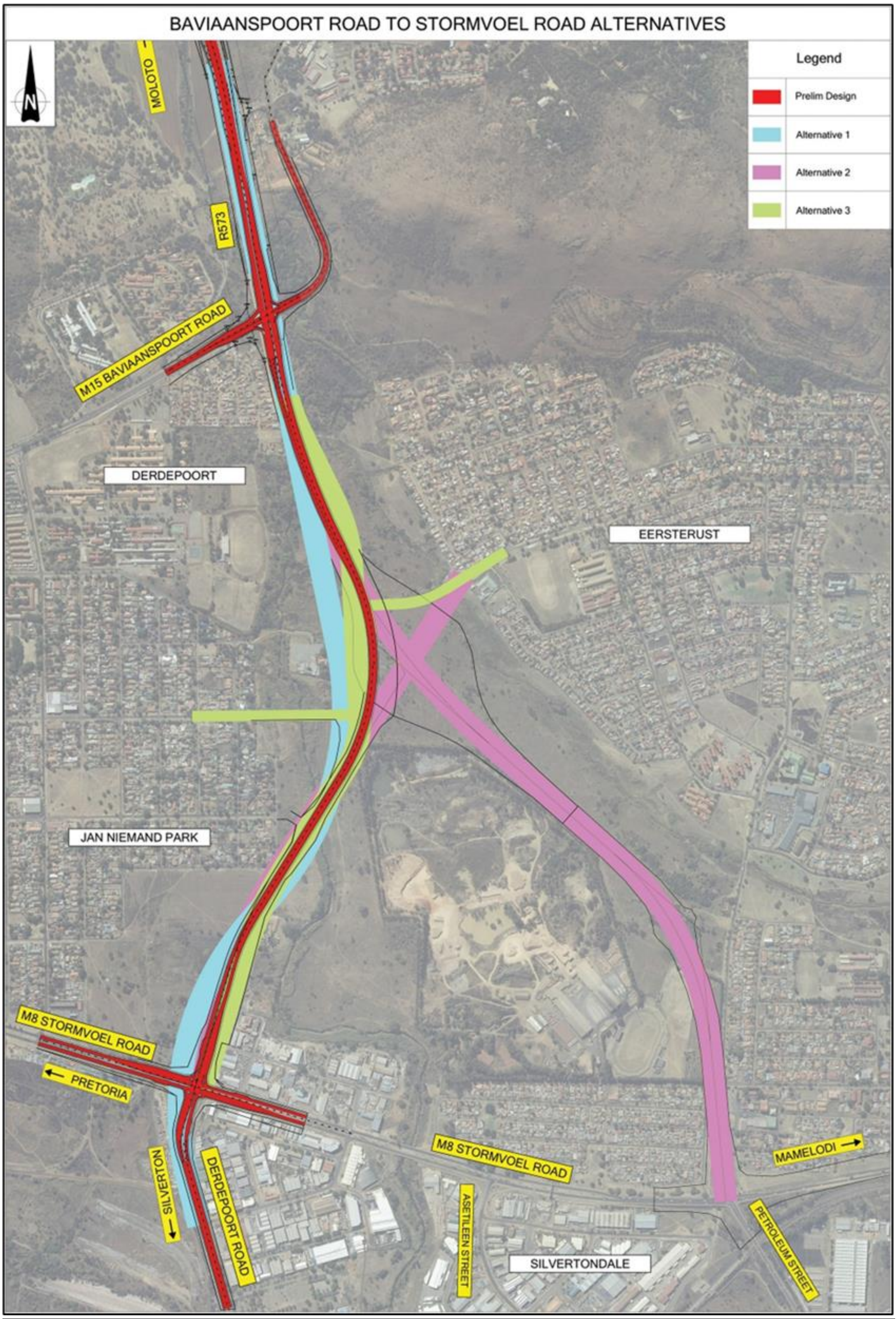
E. Description of property or affected environment

Location and depth:

The proposed Basic Assessment and Water Use Authorisation Process for the Proposed Upgrade of National Road R573 Section 1 (Moloto Road), Gauteng Province, Part 1: R573 From Baviaanspoort Road (M15) to Stormvoël Road (M5) and Moepel Road Overpass will be situated in the City of Tshwane Metropolitan Municipality, Gauteng Province on the Farms Hartbeestpoort 328-JR, Silvertondale, Jan Niemandpark, Derdepoort 326-JR, Wolmaranspoort Agricultural Holdings, and Derdepoortpark.

Depth is determined by the related infrastructure to be developed and the thickness of the formation in the development area as well as depth of the foundations, footings and channels to be developed. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops. The depth can be verified with test pit results or drill cores and is determined by the depth of the road.

Figure 2: Location map (GA Environment).



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The area is approximately 2.3 kilometres in length with the Moepel Overpass at 700 km.

F. Description of the Geological Setting

Description of the rock units:

Figure 3: Excerpt of 1:250 000 Geological Map 2528 Pretoria (Walraven 1978) (**1h)**.

Legend to map and short explanation.

M – Alluvium (yellow). Quaternary.

di – Diabase (green). Vaalian to post Mockolian.

Vsi – Shale, carbonaceous in places; hornfels; chert (brown). Silverton Formation, Pretoria Group, Transvaal Supergroup. Vaalian.

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

------ - Concealed geological boundary.

⊥36 – Strike and dip of bed.

□ – Proposed development (blocked in black).

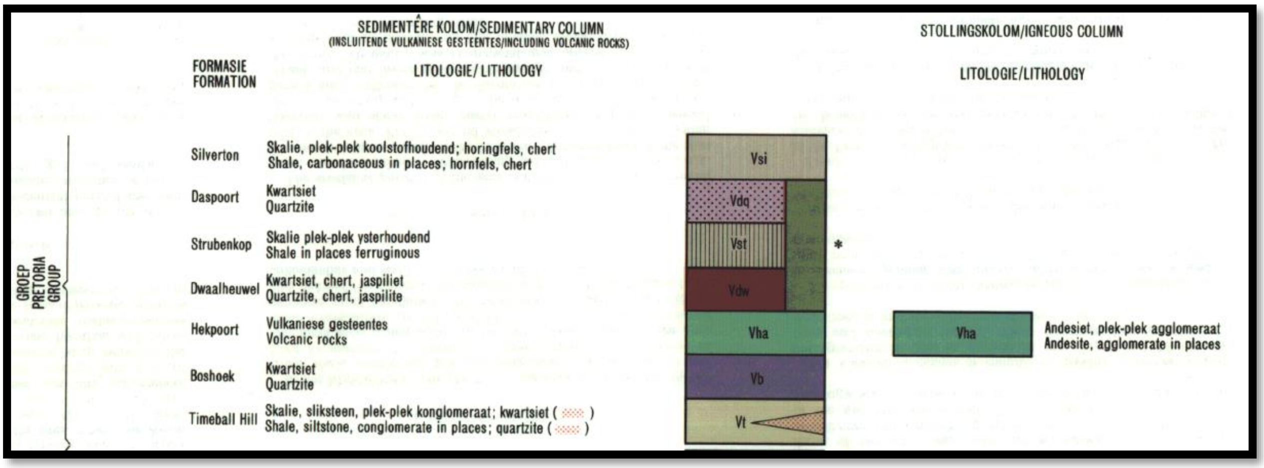
Mining Activities on Figure 3:

Ag – Silver Cu – Copper CS –Shale, brick clay.

The mining past and present has no influence on the development.

The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga) as far south as Potchefstroom. It is Vaalian in age, approximately 2600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2000 m in the north-eastern section. The east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Pretoria and Chuniespoort Groups as well as other smaller groups (Kent 1980, Snyman 1996). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. Three prominent ridges are present from the oldest to the youngest, the Time Ball Hill, Daspoort and Magaliesberg Formations (Norman and Whitfield 2006).

Figure 4: Lithostratigraphy (Walraven 1978).



The Rooiberg Group is a 2500-6000m thick succession of feldspathic quartzites, arkoses and shales, with interbedded volcanics and felsites. It consists of two formations, the lower Damwal (Vdr) and the upper Selons River (Vs), restricted in its distribution to the central part of the basin (Kent 1980, Snyman 1996). The Selons River Formation has either a sandstone or a quartzite at its base and mainly consists of red rhyolite. It (Selons River) was further subdivided into the lower Doornkloof Felsite Member and an upper Klipnek Felsite Member (Kent 1980, Visser 1989) and west of Warmbath (Bela Bela) it is again subdivided into two units, the Kwaggasnek Formation and the Schrikkloof Formation. This group has an estimated age of 2,150 Ma (Visser 1989).

The Pretoria Group consists predominantly of quartzite and shale, together with a prominent volcanic unit, minor conglomerate, chemical and volcanic members. It comprises the Hekpoort Andesite, Dullstroom Basalt, Time Ball Hill, Silverton, and Magaliesberg Quartzite Formations as well as several smaller formations (in total 15) and overlies the Chuniespoort Group (Kent 1980). Both the shale and quartzite of the Pretoria Group are utilised in the building industry (Snyman 1996). The Rayton Formation (Vr) is present northeast of Pretoria and is approximately 1,200 m thick. It consists of four layers of quartzite alternating with four layers of shale (Visser 1989). In the central part of the basin the quartzite and shale overlying the Magaliesberg Quartzite are combined into the Rayton Formation because intrusion of numerous diabase sills has made it impossible to recognise all the individual formations (Kent 1980). Below the Dullstroom, Houtenbek, Steenkampsberg, Lakenvlei and Vermont Formations is the Magaliesberg Formation which is 300 m thick in the Pretoria region and up to 500 m thick in the Lowveld (Visser 1989).

The Dullstroom Formation reaches a distance of 70 km and reaches a thickness of 400 m. A thickness of 140-255 m is attained by the Houtenbek Formation, 470-630 m for the Steenkampsberg Formation, 160-300 for the Lakenvlei Formation, and 450-800 m for the Vermont Formation (Visser 1989).

The Magaliesberg is a dominant feature of the Gauteng landscape and is north-dipping (Norman and Whitfield 2006). It was shaped by glaciation during Dwyka times and then slightly modified by post-glacial erosion (McCarthy and Rubidge 2005). The hard quartzites form prominent mountain ranges such as the Magaliesberg Mountains (McCarthy and Rubidge 2005). The Silverton shales are rich in carbon and pyrite and show cross-bedding. Brown to khaki-weathering shales is stratigraphically below the Magaliesberg Formation. These shales are visible in road cuttings. The Silverton shale Formation is the thickest of all the shale formations of the Pretoria Group (300-3000 m). It forms wide valleys and when changed to hornfels can be used for roof coverings (Visser 1989). The pile of sedimentary rocks, mainly mudstones and quartzites with some basalt can collectively reach a thickness of up to 5 km. Both the shale and quartzite of the Pretoria Group are utilised in the building industry (Snyman 1996).

The Strubenkop Formation (Vst) is fairly thin (20-80 m) in the east, but thicker towards its central part, up to 130 m thick towards the west. It is enriched with iron in the vicinity of Pretoria. The Boshoek Formation (Vb) is relatively thin (90m) and together with the Dwaalheuwel Formation (Vdw) is present in the eastern former Transvaal only consisting of quartzite. The Hekpoort Andesite Formation (Vha) is usually well developed, except for the Mokopane and Thabazimbi regions (Visser 1989) and can be up to 500 m thick with andesite, basalt and pyroclasts. These sheets are massive with an amygdaloidal crust on top (Snyman 1996). It is rich in green hornblende with an age between 2,224 ± 21 Ma (2626 Wes Rand sheet info). The Dwaalheuwel Formation is only present in the Mokopane area, above the Hekpoort Formation. In the east it is grouped with the Strubenkop Formation and the Daspoort Formation. The Daspoort Formation is between 90 to 190 m thick (Visser 1989).

The Time Ball Hill shale Formation (Vt) is known to contain 'algal microfossils' diagenetic in origin. Stromatolites as they are known are preserved in the subordinate carbonate rocks (Kent 1980). The Pretoria Group is clastic sedimentary in nature (Eriksson 1999). The pile of sedimentary rocks, mainly mudstones and quartzites with some basalt can collectively reach a thickness of up to 5 km. The Rooihoogte Formation sits at the base of the Pretoria Group and is quite thin (10 – 150 m). The chert is present as boulders or a breccia. It is often lumped with the Time Ball Hill Formation (Visser 1989).

The Chuniespoort Group is made up of chemical and biochemical sediments such as dolomite, chert, limestone and banded iron formation, carbonaceous shale is also present. At the top of the Malmani Subgroup is the Duitschland Formation underlain by the Penge and Monte Christo Formations. Sandstone is mostly absent. It is this formation that has great economic value for its lead, zinc, dolomite, and manganese (Kent 1980, Snyman 1996). Fluorspar, concrete aggregate, iron ore and manganese are also mined from this formation. Cave formation in the dolomite is a major concern in developing areas, especially in the 1500m thick dolomite of the Malmani Subgroup. Chemical sediments such as fine-grained limestone and dolomite is made up of deposits of organically derived carbonate shells, particles or precipitate. Dolomite is magnesium-rich limestone formed from algal beds and stromatolites. The Black Reef Formation is known for stromatolite carbonates and fossiliferous Late Cenozoic cave breccias similar to the Malmani dolomite.

Vaalian to post-Mokolian diabase (di) intrusions occur throughout the area in the form of plates, sills and dykes. These plates are common in the Transvaal Supergroup and when present in the Pretoria Group they are referred to as the Transvaal diabase (Kent 1980, Visser 1989). The diabase sills of Bushveld age (Norman and Whitfield 2006) is typically fine-grained, green-grey with plagioclase and pyroxenes (Visser 1989).

There is some concern with the project due to the presence of the Silverton Formation and the stromatolites. The depth of the formations can be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the shale layer if fossils are present.

G. Background to Palaeontology of the area (1j)

<u>Summary</u>: 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).

One of the formations in the development area may contain fossils. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

Chemical sediments such as fine-grained limestone and dolomite of the Malmani Subgroup is made up of deposits of organically derived carbonate shells, particles or precipitate. Dolomite is magnesium-rich limestone formed from algal beds and stromatolites. These Early Proterozoic Transvaal stromatolitic dolomites formed and released free oxygen at around 2900 – 2400 Ma. Stromatolites are common in the Malmani dolomites, accepted to be the fossil remnants of the simplest single-celled organisms. They are finely layered, concentric, mound-like structures formed by microscopic algal organisms (Norman and Whitfield 2006). Chert may contain fossils such as echinoids or sponges if nodular, although not common and is rated unlikely.

Figure 5: Stromatolite in dolomite (Photograph E. Butler).

Table 1: Taken form The Palaeotechnical Report (Groenewald and Groenewald 2014) (**1cA)**.

Magaliesberg (Vmg)(Vlm)		Coastal sandstones with mudrocks	Microbial mat structures (Desiccated mats sometimes resemble trace fossils)	Pretoria Group subunits with stromatolites probably also contain microfossils. This may also apply to carbonaceous mudrocks. ALERT FOR POTENTIALLY FOSSILIFEROUS LATE CAENOZOIC CAVE BRECCIAS WITHIN OUTCROP AREA OF CARBONATE SUBUNITS – i.e. LIMESTONES DOLOMITES (breccias not individually mapped) Rooiberg Group was previously included within top of Transvaal Supergroup but now regarded as separate succession
Silverton (Vsi)		Marine mudrocks with minor carbonates, volcanic rocks (Machadodorp Member)	Stromatolites	
Igneous intrusions (Vdi)		Igneous intrusions	No fossils recorded	
Daspoort (Vda, Vhd, Vdq; Vdp)		Alluvial, fluvial and deltaic sandstones and mudrocks, marine sediments in east	Stromatolites	
Strubenkop (Vs, Vst; Vhd)		Lacustrine mudrocks with minor sandstone	No fossils recorded	
Dwaalheuwel (Vdw, Vhd)		Alluvial sandstones, conglomerates and mudrocks	No fossils recorded	
Hekpoort (Vh, Vhd, Vha)		Volcanics (basalts, pyroclastics) with minor lacustrine shales	No fossils recorded	
Boshoek (Vb)		Sandstones, conglomerats, diamictite (alluvial fans, slumps)	No fossils recorded	
Timeball Hill (Vt; Vti)	Klapperkop (Vkp)	Lacustrine and fluvio-deltaic mudrocks with diamictite, conglomerates, quartzite, minor lavas. Shale, siltstone, conglomerate, quartzite	Stromatolites	
Rooihoogte (Vt)		Basal breccio-conglomerates, quartzites, mudrocks, carbonates (alluvial fan, lakes, karst infill)	No fossils recorded	

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity is generally **LOW** to **VERY HIGH**, but here locally **HIGH** for the Silverton Formation and **MODERATE** for the Pretoria Group.

ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that aPhase II PIA will be applicable during the construction phase of projects.

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA) (**1cB)**.

Rock Unit	Significance/vulnerability	Recommended Action
Silverton Formation (Vsi)	High	Field assessment and protocol for finds is required
Pretoria Group	**Moderate**	Desktop Study and Field Assessment likely

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: HIGH. There may be significant fossil resources that may be impacted by the development (shale/dolomite).

The project includes four Alternatives (Figure 2) with the same impact.
Preferred: Prelim Design - crosses the riparian area at three sections (red).
Alternative 1: Crosses the riparian area of the Moreleta Spruit at two sections (blue).
Alternative 2: Follow a completely different route to the east (purple).
Alternative 3: This route is further removed from the residential areas and the schools (lime).
The area is approximately 2.3 kilometres in length with the Moepel Overpass at 700 km.

H. Description of the Methodology (1e)

The palaeontological impact assessment desktop study was undertaken in June 2020 during the official covid-19 lockdown. A Phase 1: Field Study will include a walk through and drive through of the affected portion and photographs (in 20 mega pixels) taken of the site with a digital camera (Canon PowerShot SX620HS). It may be necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. A literature survey is included and the study relied on literature, geological maps, google.maps, and google.earth images.

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

Assumptions and Limitations (**1e**):-

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

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.

4. Lack of published data.
5. Lack of rocky outcrops.
6. Inaccessibility of site.
7. Insufficient data from developer and exact lay-out plan for all structures (for this report all required data/information was provided).

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

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

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

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

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

<u>Act No. 25 of 1999. National Heritage Resources Act, 1999.</u>
The National Estate as: 3 (2) (f) archaeological and palaeontological sites, (i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,
Heritage assessment criteria and grading used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;
(b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 3: Other heritage resources worthy of conservation.
SAHRA is responsible for the identification and management of Grade 1 heritage resources.
Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.
Local authorities identify and manage Grade 3 heritage resources.

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

Archaeology, palaeontology and meteorites: Section 35.
(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage

resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

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

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

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

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

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

I. Description of significant fossil occurrences

One of the formations in the development area may contain fossils. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

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

J. Recommendation (1o,1p, 1q)

a. There is no objection (see Recommendation B) to the development, it will be necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops if a chance fossil is found as the palaeontological sensitivity is **HIGH**. A Phase 2 Palaeontological Mitigation is only required if a Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during clearing, construction excavations, drilling and blasting. The Protocol for Chance Finds and Management Plan is attached (Appendix 2) for the ECO.

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

c. Preferred choice: All Alternatives has the same impact (see Executive Summary).

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

e. Consultation with parties was not necessary.

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: Only if a fossil is unearthed.
d. Permits for mitigation: **SAHRA/PHRA**.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was provided by GA Environment.
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, a 30 m no-go barrier constructed and a palaeontologist should be called in to determine proper mitigation measures, especially for shallow caves.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment (fossils) and adjacent areas as well as for safety and security reasons.

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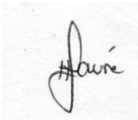
Declaration (disclaimer) 1(b)

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

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

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

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



Heidi Fourie
2020/06/18

Appendix 1 (**1k,1l,1m**): **Protocol for Chance Finds and Management plan for EMP'r**

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

The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities.

- The protocol is to immediately cease all construction activities if a fossil is unearthed and contact SAHRA for further investigation.
- The area must be fenced-off with a 30 m barrier and the construction workers must be informed that this is a no-go area.
- If fossils were found, they must be placed in a safe area for further investigation.
- The ECO should familiarise him- or herself with the fossiliferous formations and its fossils.
- A site visit is recommended after drilling, excavations and blasting and the keeping of a photographic record. A regular monitoring presence over the period during which excavations are made, by a palaeontologist, is generally not practical, but can be done during ground breaking.
- The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Ecca Group Fossils.
- The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining (if applicable) 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 (if present). 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 fossil 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 (if applicable)/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
2. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor / developer needs to stop all work.
3. 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.
4. 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.
5. 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.
6. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once a week).
7. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

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

SAHRA Documents:

Guidelines to Palaeontological Permitting Policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports for all the Provinces.

Appendix 2: Table of Appendix 6 requirements.

Section in Report	Point in Act	Requirement
B	1(c)	Scope and purpose of report
B	1(d)	Duration, date and season
B	1(g)	Areas to be avoided
D	1(ai)	Specialist who prepared report
D	1(aii)	Expertise of the specialist
F Figure 3	1(h)	Map
B	1(ni)(niA)	Authorisation
B	1(nii)	Avoidance, management, mitigation and closure plan
G Table 1	1(cA)	Quality and age of base data
G Table 2	1(cB)	Existing and cumulative impacts
D	1(f)	Details or activities of assessment
G	1(j)	Description of findings
H	1(e)	Description of methodology
H	1(i)	Assumptions
J	1(o)	Consultation
J	1(p)	Copies of comments during consultation
J	1(q)	Information requested by authority
Declaration	1(b)	Independent declaration
Appendix 2	1(k)	Mitigation included in EMPr
Appendix 2	1(l)	Conditions included in EMPr
Appendix 2	1(m)	Monitoring included in EMPr
D	2	Protocol or minimum standard

Appendix 3: Impact Tables.

ASSESSMENT CRITERIA
a) Nature of Impact
This is an appraisal of the type of effect the proposed activity would have on the affected environmental component. The description should include what is being affected, and how.
b) Extent
The physical and spatial size of the impact. This is classified as: **i) Site** The impact could affect the whole, or a measurable portion of the site. **ii) Local** The impacted area extends only as far as the activity, e.g. a footprint of the specific activity

iii) Regional

The impact could affect areas such as neighbouring farms, transport corridors and the adjoining towns.

c) Duration

The lifetime of the impact; this is measured in the context of the lifetime of the proposed project.

i) **Short term**

The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than any of the phases.

ii) Medium term

The impact will last up to the end of the phases, where after it will be entirely negated.

iii) Long term

The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter.

iv) Permanent

The only class of impact which will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

d) Intensity

Is the impact destructive or benign? Does it destroy the impacted environment, alter its functioning, or slightly alter it? These are rated as:

i) Low

The impact alters the affected environment in such a way that the natural processes or functions are not affected.

ii) Medium (Moderate)

The affected environment is altered, but function and process continue, albeit in a modified way.

iii) High

Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases. This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project.

e) Probability

This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:

i) Improbable

The possibility of the impact occurring is very low, due either to the circumstances, design or experience.

ii) Probable

There is a possibility that the impact will occur to the extent that provisions must be made.

iii) Highly probable

It is most likely that the impacts will occur at some or other stage of the development. Plans must be drawn up before the undertaking of the activity.

iv) Definite

The impact will take place regardless of any prevention plans, and mitigation actions or contingency plans are relied on to contain the effect.

f) Determination of significance

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The classes are rated as follows:

i) No significance

The impact is not substantial and does not require any mitigation.

ii) Low

The impact is of little importance, but may require limited mitigation.

iii) Medium (Moderate)

The impact is of importance and therefore considered to have a negative impact. Mitigation is required to reduce the negative impacts to acceptable levels.

iv) High

The impact is of great importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation

g) Reversibility of impact

Natural or human aided intervention

(i) Irreversible

The impact will be permanent

(ii) Short term

The impact is reversible within two years after construction **(iii) Long term** The impact is reversible within 2 to 10 years after construction
f) The degree to which the impact can cause irreplaceable loss of resources
(i) Low The impact result in the loss of resources but the natural, cultural and social processes/functions are not affected **(ii) Medium** The loss of resources occurs but natural cultural and social processes continue, albeit in a modified manner **(iii) High** The impact result in irreplaceable loss of resource

1.1 Impact Summary

The development footprint is situated on the Silverton Formation (Svi) of the Pretoria Group (Transvaal Supergroup) with a high palaeontological sensitivity. The Nature of the impact is the destruction of Fossil Heritage. Loss of fossil heritage will have a negative impact. The probability of the impact occurring will be probable. The expected duration of the impact is assessed as potentially permanent. Only the site will be affected. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent. With Mitigation the impact will be low and the cumulative impact is low. Impacts on palaeontological heritage during the construction and preconstruction phase could potentially occur but are regarded as having a minor possibility. The significance of the impact occurring will be moderate.