

Proposed development of the Fort Recce Museum and Resort with related infrastructure

City of Tshwane Metropolitan Municipality, Gauteng Province

Farm: Portion 280 (Portion of Portion 26) of the Farm Tiegerpoort 371 JR

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Palaeontological Impact Assessment: Desktop study

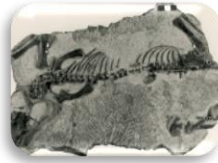
Facilitated by: LEAP

P.O. Box 13185, Hatfield, 0028

Tel: 012 344 3582

2017/01/24

Ref: Pending



B. Executive summary

Outline of the development project: LEAP has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Desktop Study of the suitability of the proposed development of the Fort Recce Museum and Resort, with related infrastructure on Portion 280 (Portion of Portion 26) of the Farm Tiegerpoort 371 JR in the City of Tshwane Metropolitan Municipality in the Gauteng Province.

The applicant, the South African Special Forces Heritage Foundation, proposes to develop the property in to a museum with guard house, functions hall, chapel, restaurant and coffee shop, offices, 2 chalets and club with related infrastructure in the east of Pretoria, City of Tshwane.

The Project includes one Option (see google.earth image):

Option 1: An area roughly rectangular blocked in red with Lynwood Road (M6) to the northeast and the Nkwe Road and Nkwe Pleasure Resort to the south. The Tierpoort hill and Glastonbury Ridge are situated next to the development area. It is approximately 8,5916 hectares in size.

The following legislation applies:-

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).

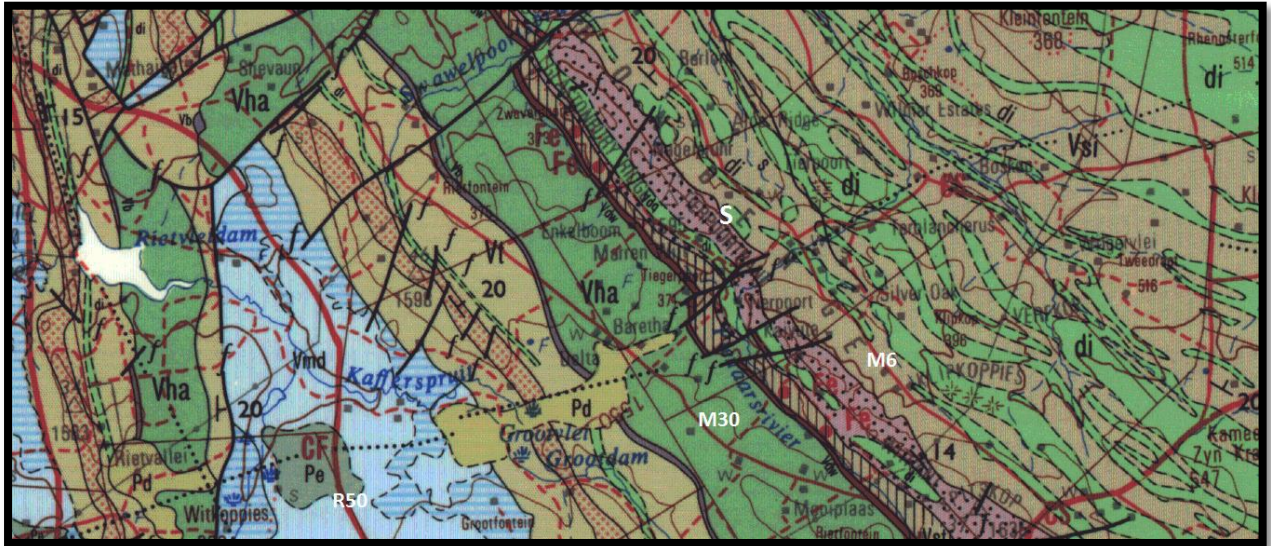
Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge 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 the 1:250 000 (2528) Geological Map of Pretoria (Walraven 1978).

Figure 3: The geology of the development area.



Legend to Map and short explanation.

- S – Syenite dyke.
- di – Diabase (light green), Vaalian to post-Mokolian age.
- Vsi – Shale, carbonaceous in places, hornfels; chert (brown), Silverton Formation, Pretoria Group, Transvaal Supergroup.
- Vdq – Quartzite (purple [::]), Daspoort Formation, Pretoria Group, Transvaal Supergroup.
- Vha – Andesite, agglomerate in places (green), Hekpoort Formation, Pretoria Group, Transvaal Supergroup.
- f--- (black) Fault.
- == - Concealed geological boundary.
- ⊥ 20 - Strike and dip of bed.
- S – Approximate position of development (in the middle of the Figure).

Mining Activities

Fe – Iron.

Summary of findings: The Palaeontological Impact Assessment: Desktop study was undertaken in January 2016 in the summer in dry and hot conditions, as this is a desktop study the season (Appendix 6 of Act, 1(d)) has no influence on the outcome, and the following is reported:

The development is taking place on the Silverton Formation (Vsi), it may overlap onto the Daspoort Formation (Vdq), both of the Pretoria Group, Transvaal Supergroup.

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).

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 Time Ball Hill shale Formation 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 Silverton shale Formation is the thickest of all the shale formations of the Pretoria Group (300 – 3000 m) (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 sedimentary rocks the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally HIGH for the Pretoria Group (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:

The impact of the development on fossil heritage is HIGH and therefore a field survey or further mitigation or conservation measures may be necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment and or mitigation may be recommended. The overburden and inter-burden must be surveyed for fossils during construction. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden during construction not to intrude fossiliferous layers.

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

Rock Unit	Significance/vulnerability	Recommended Action
Pretoria Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely

The Project includes one Option (see google.earth image):

Option 1: An area roughly rectangular blocked in red with Lynwood Road (M6) to the northeast and the Nkwe Road and Nkwe Pleasure Resort to the south. The Tierpoortrant hill and Glastonbury Ridge are situated next to the development area. It is approximately 8,5916 hectares in size.

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 may be needed when a fossil is found, pending comments from SAHRA.
3. No consultation with parties was necessary.
4. Alternatives will not be feasible.
5. The development may go ahead with caution for the shale layers, when a fossil is found, all construction must stop, and SAHRA must be notified.

Stakeholders: Developer – South African Special Forces Heritage Foundation, Postnet Suite 443, Private Bag x15, Menlo Park, 0102.

Environmental – LEAP, P.O. Box 13185, Hatfield, 0028, Tel. 012 344 3582.

Landowner – South African Special Forces Heritage Foundation, Mr C. Roos, 27 Colin Road, Eldoraigne, 0157.

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D. Background information on the project

Report

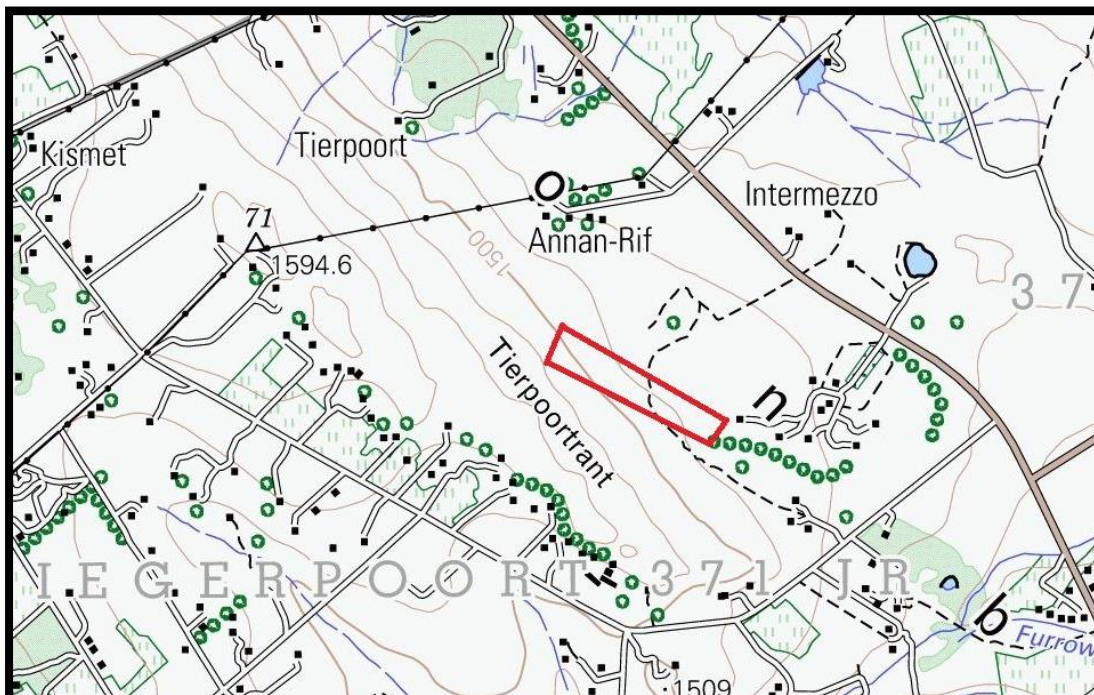
This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 2).

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 applicant, the South African Special Forces Heritage Foundation, proposes to develop the property in to a museum with an Entrance Guard House, Museum, Functions Hall, Recce Retail Office, Fort Recce Chapel, Fort Recce Restaurant and Coffee Shop, SA Special Forces Association Offices, SA Special Forces Heritage Foundation Offices, 2 Overnight Chalet Accommodation Units, and SA Special Forces Members Club with related infrastructure in the east of Pretoria, City of Tshwane.

Figure 1: Topographic map 2528CD Pretoria showing location (LEAP).



The following infrastructure is anticipated:

1. Roads,
2. Buildings and parking,
3. Water services,
4. Sewerage services,
5. And associated infrastructure such as electricity lines.

The Project includes one Option (see google.earth image):

Option 1: An area roughly rectangular blocked in red with Lynwood Road (M6) to the northeast and the Nkwe Road and Nkwe Pleasure Resort to the south. The Tierpoortrant hill and Glastonbury Ridge are situated next to the development area. It is approximately 8,5916 hectares in size.

Rezoning/ and or subdivision of land: Yes, from Undetermined to Special.

Name of Developer and Environmental Consultant: South African Special Forces Heritage Foundation and LEAP.

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

Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past ten 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 proposed development of the Fort Recce Museum and Resort, with related infrastructure will be situated on Portion 280 (Portion of Portion 26) of the Farm Tiegerpoort 371 JR in the City of Tshwane Metropolitan Municipality in the Gauteng Province. The development will be a dream come true for the South African Special Forces Heritage Foundation.

Depth of intrusion into geological layers is determined by the development and related infrastructure.

The Project includes one Option (see google.earth image):

Option 1: An area roughly rectangular blocked in red with Lynwood Road (M6) to the northeast and the Nkwe Road and Nkwe Pleasure Resort to the south. The Tierpoortrant hill and Glastonbury Ridge are situated next to the development area. It is approximately 8,5916 hectares in size.

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



The bulk of the site is underlain by the Transvaal Supergroup rocks.

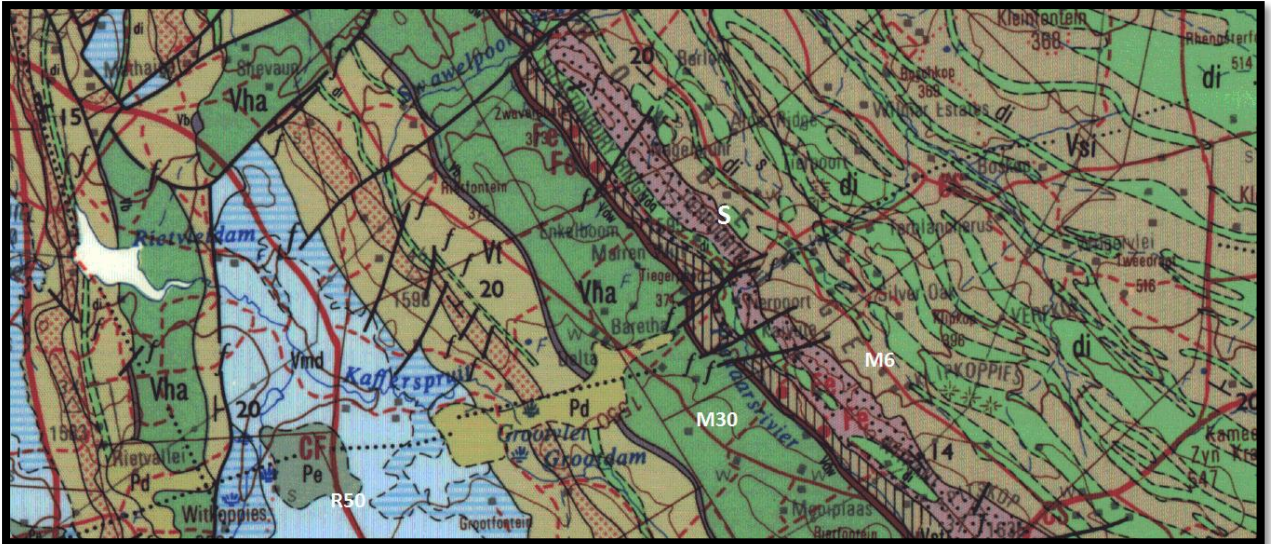
F. Description of the Geological Setting

Description of the rock units:

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 northeastern 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, Chuniespoort, and Pretoria 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).

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 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 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 Time Ball Hill shale Formation is known to contain 'algal microfossils' diagenetic in origin. Stromatolites as they are known are preserved in the subordinate carbonate rocks (Kent 1980). The Daspoort Formation is quite thin (90 m) in the east, but gradually increases in thickness to the west to 190 m thick. The orthoquartzite is interlayered with thin shale and siltstone (Visser 1989).

Figure 3: The geology of the development area (Walraven 1978).



Legend to Map and short explanation.

S – Syenite dyke.

di – Diabase (light green), Vaalian to post-Mokolian age.

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

Vdq – Quartzite (purple [.:]), Daspoort Formation, Pretoria Group, Transvaal Supergroup.

Vha – Andesite , agglomerate in places (green), Hekpoort Formation, Pretoria Group, Transvaal Supergroup.

---f--- (black) Fault.

== - Concealed geological boundary.

⊥ 20 - Strike and dip of bed.

S – Approximate position of development (in the middle of the Figure).

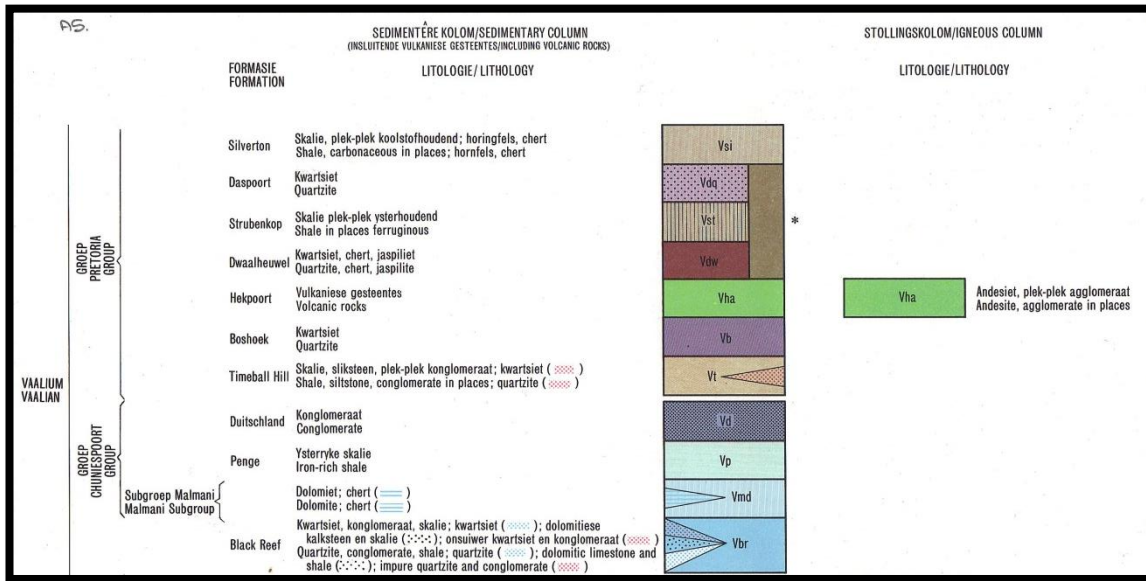
Vaalian to post-Mokolian diabase (di) intrusions occur throughout the area in the form of plates, sills and dykes. These plates are common in the Transvaal Supergroup and when present in the Pretoria Group they are referred to as the Transvaal diabase (Kent 1980, Visser 1989). The diabase sills of Bushveld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

The Silverton Formation is present here in the development area, it may overlap onto the Daspoort Formation. The Pienaarsrivier is close by with a fault line where the Nkwe Road is. The Tierpoortrant hill is part of the Bronberg Range adjoining on the Glastonbury Ridge.

The Project includes one Option (see google.earth image):

Option 1: An area roughly rectangular blocked in red with Lynwood Road (M6) to the northeast and the Nkwe Road and Nkwe Pleasure Resort to the south. The Tierpoortrant hill and Glastonbury Ridge are situated next to the development area. It is approximately 8,5916 hectares in size.

Figure 4: Lithostratigraphic column of the geology of the site (Muntingh 1992).



It is recommended to wait for the response from SAHRA on the Desktop Study (this report), and if a Phase 1: Field study is recommended then SAHRA protocol must be followed. Alternatives will not be feasible.

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).

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. These Early Proterozoic Transvaal stromatolitic dolomites formed and released free oxygen at around 2900 – 2400 Ma. Stromatolites are common in the Malmani (Vmd) 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).

Figure 5: Example of a stromatolite present in dolomite (Photograph: E. Butler).



Stromatolites are significant indicators of palaeoenvironments and provide evidence of algal growth between 2640 and 2432 million years ago (Groenewald and Groenewald 2014). Caves in the Malmani dolomite (Vmd) of the Transvaal Supergroup provided a refuge for man's distant ancestors (Norman and Whitfield 2006). These caves are also home to Middle and Late Stone Age cultures. The cave breccia in the Cradle of Humankind, near Johannesburg, yielded internationally renowned hominins such as *Australopithecus africanus* and *robustus* and extinct mammals and other fauna. The caves are actively being researched and excavated and this has led to many international collaborations. The caves are filled with sediments from the Kalahari Group.

In the rocks overlying the Black Reef Formation there is evidence for life on an abundant scale as cyanobacteria came to dominate the shallow sea forming stromatolites of varying shapes. Large, elongate stromatolite domes can be seen at Boetsap in the North West Province (McCarthy and Rubidge 2005) and the algal microfossils reported from the Time Ball Hill Formation shales are probably of diagenetic origin (Eriksson 1999).

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

Subgroup/sequence	Group	Formation	Fossil Heritage	Comment
Transvaal Supergroup	Pretoria	Silverton (Vsi).	Stromatolites.	Marine mudrocks with minor carbonates, volcanic rocks. Probably also contain microfossils. This may also apply to carbonaceous mudrocks.

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

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

Rock Unit	Significance/vulnerability	Recommended Action
Pretoria Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely

Databases and collections: Ditsong: National Museum of Natural History.

Impact: HIGH for the Pretoria Group, Transvaal Supergroup. There are significant fossil resources that may be impacted by the development and if destroyed are no longer available for scientific research or other public good.

H. Description of the Methodology

The palaeontological impact assessment desktop study was undertaken in January 2016. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images.

Assumptions and Limitations (Appendix 6 of Act 1(i):-

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

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

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

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.

5. Background to palaeontology of the area.
6. Field Rating.
7. Stating of Significance (Heritage Value).

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

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

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

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

National Estate: 3 (2) (f) archaeological and palaeontological sites,

(i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,

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

(b) Grade 11: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 111: Other heritage resources worthy of conservation.

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

Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 11 heritage resources.

Local authorities identify and manage Grade 111 heritage resources.

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

Archaeology, palaeontology and meteorites: Section 35.

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

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

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

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

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

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

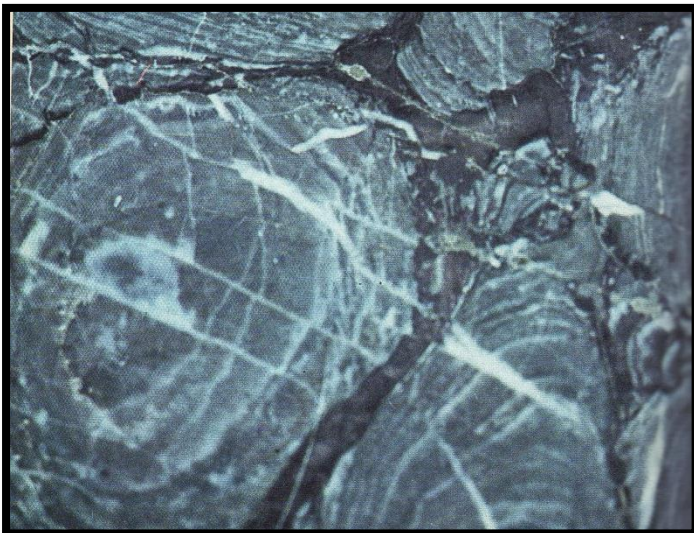
Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences

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.

Stromatolites are likely to be present. These structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

Figure 6: Thin section of a stromatolite (De Zanche and Mietto 1977).



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

- There is no objection (see Recommendation B) to the development, and it is not necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops. The palaeontological sensitivity is **HIGH** so caution is recommended. A Phase 2 Palaeontological Mitigation may be required if a fossil is found during construction (for example a stromatolite).
- This project may benefit the economy, the growth of the community and social development in general.
- Preferred choice: The impact on the palaeontological heritage is **HIGH**. Care must be taken during the grading of roads, digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary) or blasting of bedrock.
- 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.

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 Desktop study was provided by the Environmental Consultant. All technical information was provided by LEAP.
- 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.

L. Bibliography

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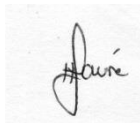
Declaration / Disclaimer (1b)

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

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

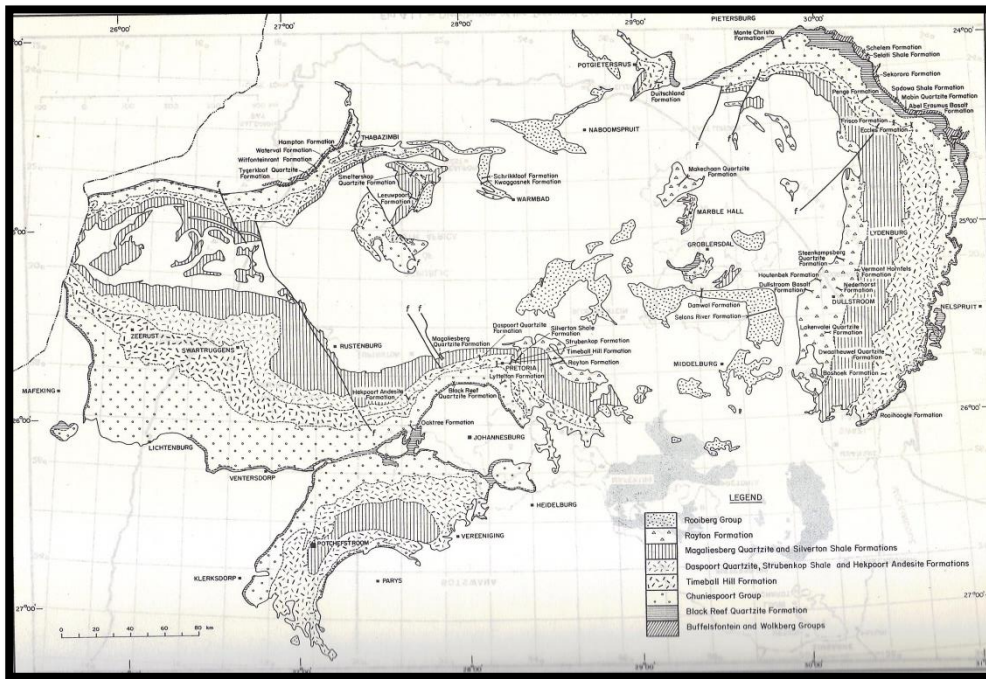
It may be possible that the desktop study may have missed palaeontological resources in the Project Area as the presence of outcrops are not known and may only be found once development commences.

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

A handwritten signature in black ink, appearing to read 'Fourie', is positioned above a horizontal line.

Heidi Fourie
2017/01/24

Appendix 1: Geology of the Transvaal Supergroup (Kent 1980).



Appendix 2:

Table 3: Listing points in Appendix 6 of the Act and position in Report.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"
	1(p)	"
	1(h)	Figures
D	1(a)i	Terms of reference
	1(e)	Description of Methodology
H	1(i)	Assumptions and Limitations
	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	"
	1(m)	Sampling and collecting
	1(k)	"
	1(b)	Declaration
Appendix 1	1(k)	Protocol for finds
	1(m)	"
	1(q)	"