Sturdee Energy PPC Slurry Solar Project

Mahikeng Local Municipality, Ngaka Modiri District Municipality, North West Province

Farm: Portion of Slurry 96-JO

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/079 940 6048

Palaeontological Impact Assessment: Desktop Study

Commissioned by: Coastal Environmental Services

39 Harewood Drive, Nahoon Mouth,

East London,

5214

043 726 7809

Ref: Pending

2021/03/07

Stromatolite (DeZanze & Mietto)

B. Executive summary

Outline of the development project: Coastal Environmental Services has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Desktop Study of the proposed Sturdee Energy PPC Slurry Solar Plant on Farm Portion Slurry 96-LO, Mahikeng Local Municipality, Ngaka Modiri District Municipality, North West Province.

The applicant, Sturdee Energy proposes to construct a PV Solar facility.

The Project includes one locality Option (Figure 2):
Option 1: Two roughly rectangular areas outlined in yellow with the R 49 Road and the Slurry railway station to the north; the R 503 Road and Mafikeng to the west; and Zeerest to the far north north-east. The area is approximately 30 ha in size.

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 could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:

The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984).

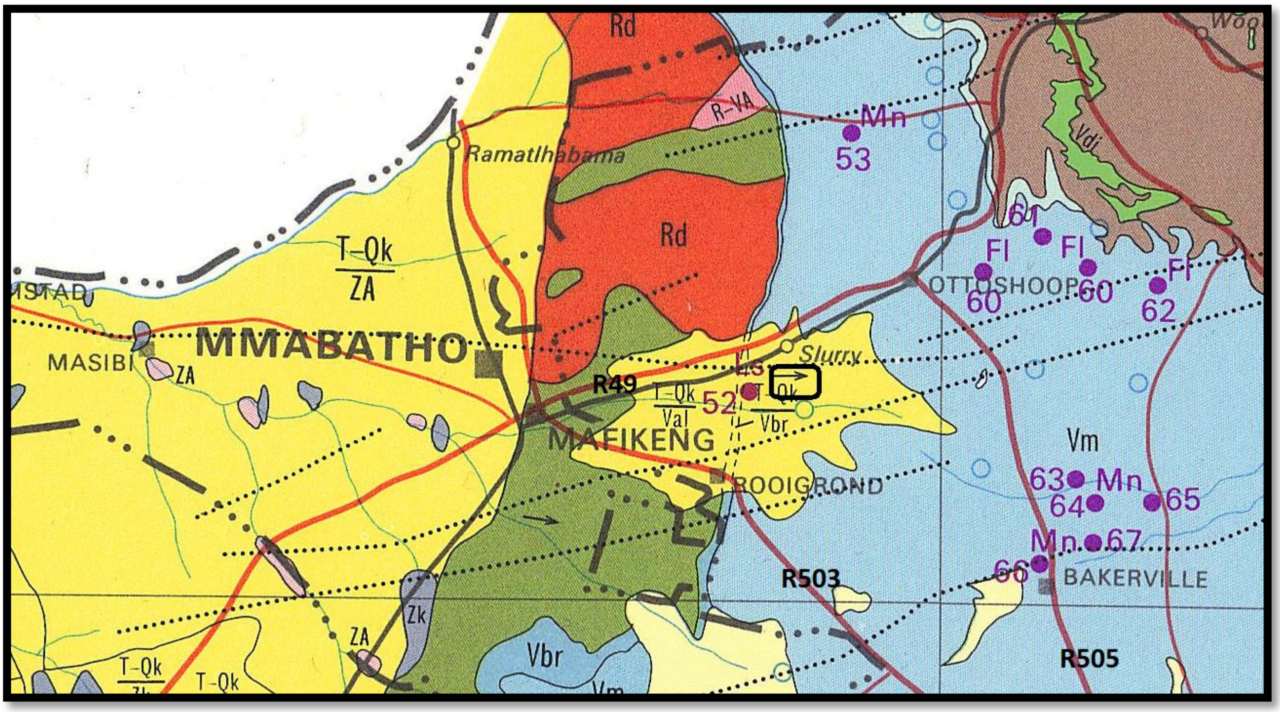

Figure 3: The geology of the development area.

Legend to map and short explanation.

T-Qk/Vbr – Sand, limestone (T-Qk) (yellow). Kalahari. Quaternary. [M]

Vm – Dolomite, chert (blue). Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup. Vaalian. [H]

Vbr – Quartzite, conglomerate, shale, basalt (dark blue). Black Reef Formation, Transvaal Supergroup. Vaalian. [M]

Val – Andesite (green). Allanridge Formation, Ventersdorp Supergroup. Vaalian. [L]

→ - Dip of normal bed.

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

------ - Concealed geological boundary.

⊥37˚ – Strike and dip of bed.

□ – Proposed development (blocked in black).

The Kalahari deposits extend in age down to at least the Late and probably the Early Tertiary (65 million years ago). Fossils are scarce, and are of terrestrial plants and animals with close affinity to living forms. Included in the Kalahari Group are the Quaternary alluvium, terrace gravels, surface limestone, silcrete, and aeolian sand. Four major types of sands have been delineated (Kent 1980, Visser 1989). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). The Kalahari Group is underlain by the Uitenhage and Zululand Groups (McCarthy and Rubidge 2005).

The Black Reef Formation of the Transvaal Supergroup consists of quartzite with lenses of grit and conglomerate. Shale is always present, particularly near the top close to the contact with the overlying dolomite (Kent 1980). It is Vaalian in age and not very thick, only up to 500m in the north-east. It contains a fair amount of gold and the limestone is mined (Snyman 1996).

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** (SG 2.2 SAHRA APMHOB, 2012).

A very wide range of possible fossil remains occur in the Cenozoic also Kalahari, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite 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).

The Black Reef Formation is known for stromatolite carbonates and fossiliferous Late Cenozoic cave breccias similar to the Malmani dolomite. Algal microfossils are reported from shales and are probably from diagenetic origin. Stromatolites are preserved in the subordinate carbonate rocks.

Summary of findings (**1d**): The Desktop Palaeontological Impact Assessment was undertaken in March 2021 in summer in hot and dry conditions (**1c)** during the official Level 1 of the Covid-19 lockdown, and the following is reported:

The Project includes one locality Option (Figure 2):
Option 1: Two roughly rectangular areas outlined in yellow with the R 49 Road and the Slurry railway station to the north; the R 503 Road and Mafikeng to the west; and Zeerest to the far north north-east. The area is approximately 30 ha in size.

The only Option presented is situated on the Tertiary Kalahari.

Recommendation:
The potential impact of the development on fossil heritage is **MODERATE** and therefore a Phase 1: Field Survey will be necessary for this development if fossils are found during construction. A Phase 2: Mitigation is recommended at the same time (according to SAHRA protocol). For a Chance Fossil Find, the Protocol is attached. Concerns/threats (**1g**) to be added to the EMPr:

1. Threats to the National Heritage 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. 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 (stromatolites) are found.

2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formations 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.
5. Care must be taken during the dolomite risk assessment as stromatolites may be present (according SANS 1936-1 (2012)) not to destroy any stromatolites.

Stakeholders: Developer – Sturdee Energy. Second Floor, Grovenor Gate, Hyde Lane Office Park, Hyde Park, Johannesburg, 1000.
Environmental – Coastal Environmental Services, 39 Harewood Drive, Nahoon Mouth, East London, 5214. Tel: 043 726 7809.
Landowner – N/a.

Appendix 3: 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

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (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.

Outline of development

This report discusses and aims to provide the applicant with information regarding the location of palaeontological material that will be impacted by the development. 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, Sturdee Energy proposes to construct a PV Solar facility.

The proposed installed generation capacity for the Plant is 11 MWp DC, with the plant delivering a maximum of 10 MW AC at 35º and power factor of 1 to the existing electricity supply network. A DC/AC ratio of 110% has been considered. Total peak power of the PV plant is 11 MWp, with a total of 23 900 PV modules of 460 Wp each. The location of the solar PV plant has been optimized within the allocated land parcels provided by the Client. A Medium Voltage (MV) overhead line (OHL) has been proposed to interconnect the PV plant to the PPC main distribution substation on each site. The following infrastructure components are proposed:

- **Mounting Structures.**

The structures chosen are oriented in a North-South axis along a single-axis horizontal axis system, which rotates the panels to orient them, at the sunrise, to the east and, at the sunset, to the West. The reason for this selection was done to enhance the total yield over the life-span of the PV system. On average this system will yield +-15% more energy (kWhrs) at the point of connection every year for the life of the plant, as compared to a fixed-tilt system at an angle of 25 degrees with no tracking. There is an additional capex associated with the tracking system due to the additional control, monitoring and associated tracker system requirements, however the Levelised Cost of

Electricity (LCOE) when considered over 20 years will be significantly lower than a fixed-tilt equivalent with all other variables held constant. This system thus has an advantage of providing a significantly lower LCOE owing to the greater solar PV yield. The tracker layout has been optimized to reduce shading significantly. This is achieved by spacing rows at a pitch of 6.5m apart thus preventing majority of inter-row shading losses and reducing back-tracking requirement. Where land is constrained, such as the De Hoek site, we had to reduce pitch distance to 4m to allow the full PV plant DC capacity to fit.

- **Buildings.**

It is included within our scope of works the construction of the following buildings:

• Substation & control room on site

• The building will be air-conditioned to maintain an adequate temperature-controlled environment for the electronic devices that will be housed within i.e. UPS, park controller, tracker controller, MV switchgear, etc

• Building will contain fire extinguishers, PPE, toolbox, spares, and working table for on-site personnel

- **Civil Works**

All civil works are designed to capable of withstand a 100-year storm event, including the effects of water, extreme winds and other natural disasters, without flooding, erosion, settlement or damage.

- **Electrical Connections**

For the interconnection with the existing PPC substation it is required to design, build and commissioning a new 11kV or 6.6kV overhead line (OHL) capable of evacuating up to 10MVA on a continual basis. Eskom Distribution standards and specifications will be used as the reference requirements to design, construct and commission the MV overhead lines.

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

- Mounting Structures.
- Buildings.
- Civil Works.
- Electrical Connections.

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

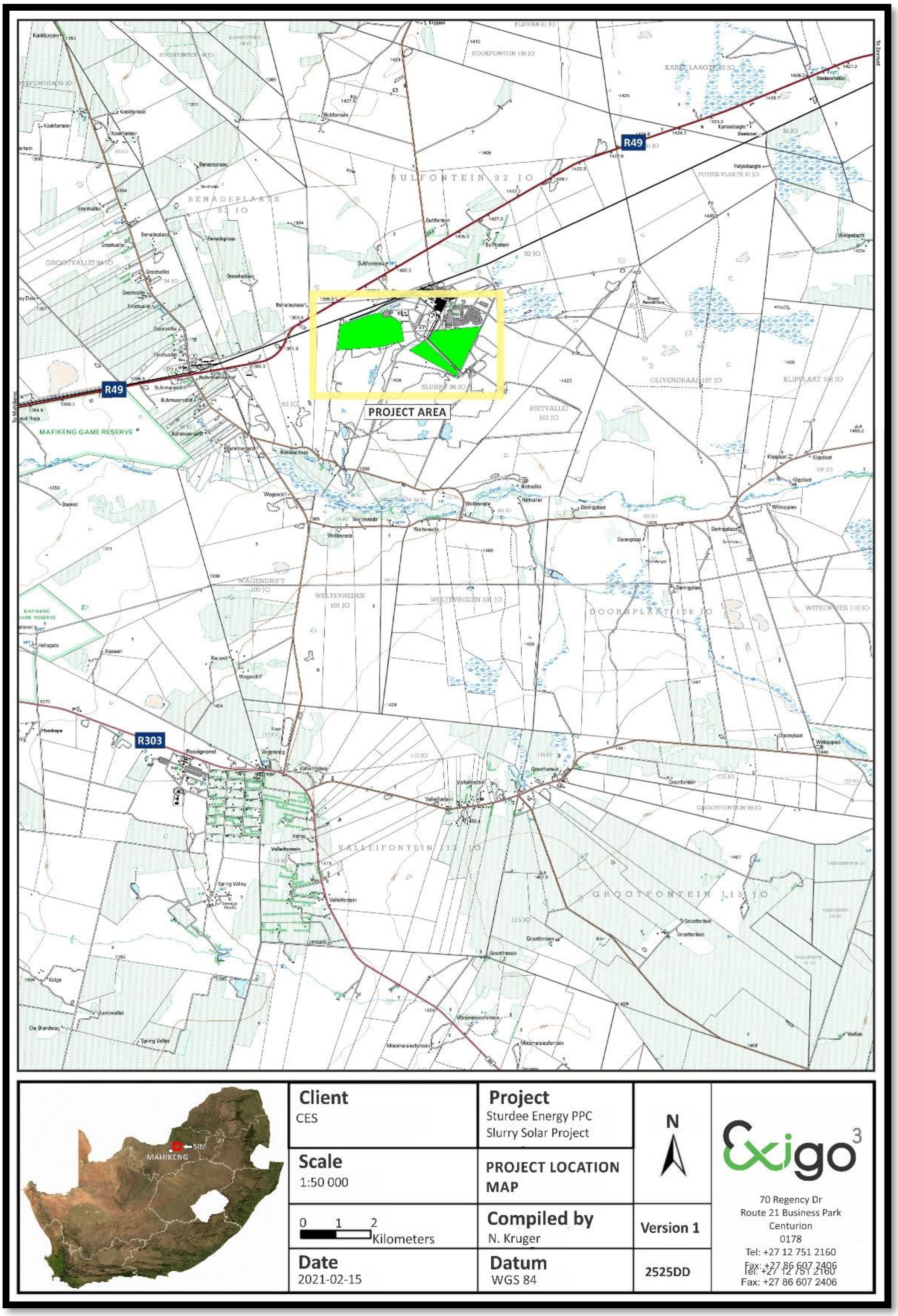

Figure 1: Topographic map (Exigo)

The Project includes one locality Option (Figure 2):

Option 1: Two roughly rectangular areas outlined in yellow with the R 49 Road and the Slurry railway station to the north; the R 503 Road and Mafikeng to the west; and Zeerest to the far north north-east. The area is approximately 30 ha in size.

<u>Rezoning/ and or subdivision of land:</u> No.
<u>Name of Developer and Environmental Consultant:</u> Sturdee Energy and Coastal Environmental Services.
<u>Terms of reference:</u> 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.
<u>*Curriculum vitae* – short (**1aii, 1aii)**:</u> 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 14 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 26 years.
<u>Legislative requirements:</u> 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
<u>Location and depth</u>:
The proposed Sturdee Energy PPC Slurry Solar Plant will be situated on Farm Portion Slurry 96-LO, Mahikeng Local Municipality, Ngaka Modiri District Municipality, North West Province.

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 building construction.

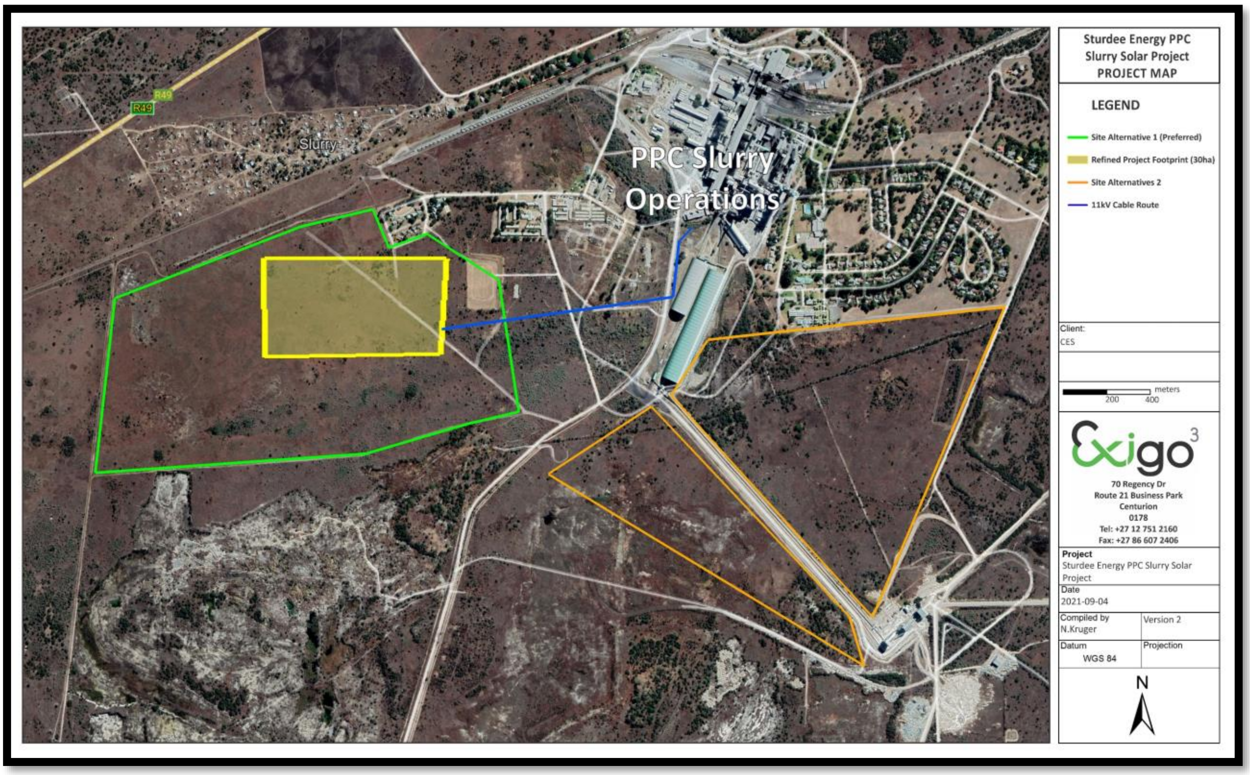

Figure 2: Google.Earth location map (Exigo).

The Project includes one locality Option (Figure 2) with Zeerest to the far north north-east and Mafikeng to the west:

Option 1: Two roughly rectangular areas outlined in yellow with the R 49 Road and the Slurry railway station to the north; the R 503 Road and Mafikeng to the west; and Zeerest to the far north north-east. The area is approximately 30 ha in size.

F. Description of the Geological Setting

Description of the rock units:

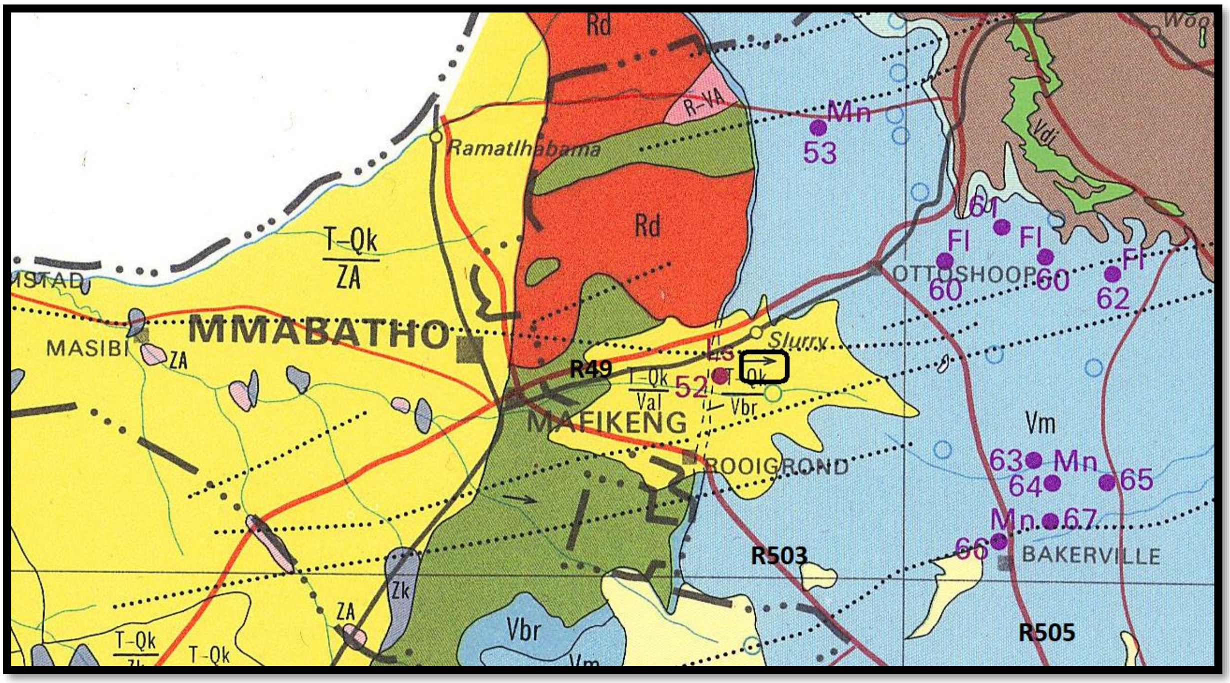

Figure 3: Excerpt of 1:100 000 Geological Map (**1h**).

Legend to map and short explanation.

T-Qk/Vbr – Sand, limestone (T-Qk) (yellow). Kalahari. Quaternary. [M]

Vm – Dolomite, chert (blue). Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup. Vaalian. [H]

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------ - Concealed geological boundary.

┴37˚ – Strike and dip of bed.

□ – Proposed development (blocked in black).

Mining Activities on Figure 3:

Ls – Limestone Mn - Manganese.

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

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually unfossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006).

The Kalahari deposits extend in age down to at least the Late and probably the Early Tertiary (65 million years ago). Fossils are scarce, and are of terrestrial plants and animals with close affinity to living forms. Included in the Kalahari Group are the Quaternary alluvium, terrace gravels, surface limestone, silcrete, and aeolian sand. Four major types of sands have been delineated (Kent 1980, Visser 1989). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). The Kalahari Group is underlain by the Uitenhage and Zululand Groups (McCarthy and Rubidge 2005). The Gordonia Formation (Qg) is of Late Pliocene / Pleistocene to Recent in age (the well-known "Kalahari Sands"). It can be up to 30 m thick and form part of a vast dune sea or erg that stretches northwards to the equator and beyond (Almond and Pether 2009).

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).

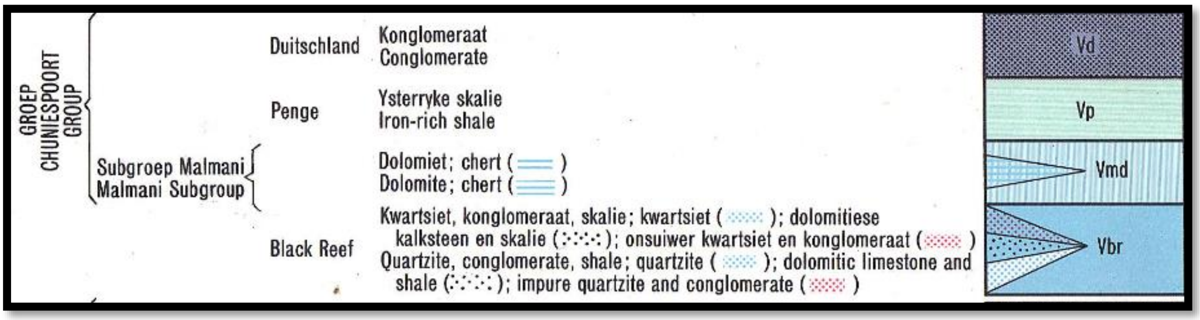

Figure 4: Lithostratigraphy (Walraven 1978).

The 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.

The Black Reef Formation of the Transvaal Supergroup consists of quartzite with lenses of grit and conglomerate. Shale is always present, particularly near the top close to the contact with the overlying dolomite (Kent 1980). It is Vaalian in age and not very thick, only up to 500m in the north-east. It contains a fair amount of gold and the limestone is mined (Snyman 1996). The Black Reef Formation is known for stromatolite carbonates and fossiliferous Late Cenozoic cave breccias similar to the Malmani dolomite. Algal microfossils are reported from shales and are probably from diagenetic origin. Stromatolites are preserved in the subordinate carbonate rocks.

The Ventersdorp Supergroup consists mainly of andesitic lava, tuff and agglomerate. The Klipriviersberg Group and the Platberg Group are Randian in age, where the Rietgat Formation is Vaalian in age (Sheet information 2626 Wes Rand). The Ventersdorp Supergroup sits disconformably on the Witwatersrand Supergroup and is made up of the lower Klipriviersberg Group, the middle Platberg Group, and two formations (Bothaville and Allanridge). Together it can reach a maximum thickness of 4,260 m in some areas. It is described as an elliptical basin named after the town of Ventersdorp. Sediments accumulated in fault-bounded troughs or grabens and gold can be present (Norman and Whitfield 2006).

A volcanic event that started 2,714 million years ago is responsible for the Klipriviersberg Group of the Ventersdorp Supergroup, further eruptions of basalt and rhyolite formed the Platberg Group (McCarthy and Rubidge 2005). The Klipriviersberg Group comprises the lowest Westonaria, followed by the Alberton, Orkney, Jeannette, Loraine, and with the uppermost Edenville Formations (Kent 1980).

Several formations make up the Platberg Group, the basal Kameeldoorns, Makwassie, and upper Rietgat Formations, the Bothaville and Allanridge Formations are grouped separately (Kent 1980). The Platberg Group consists predominantly of Randian age and Vaalian age rocks. The Rietgat Formation which is the predominant formation in the development area sits concordantly on the Makwassie Formation consisting of green-grey amygdaloidal, porphyritic lava (Garfield Member), interlayered with shale, tuff, greywacke conglomerate, and impure lacustrine limestone with algal stromatolites (2626 Wes Rand sheet info, Kent 1980). Soils forming can be divided into three groups with the solid lavas creating excellent conditions for foundations, the residual soils and the tuffs are not ideal for foundations (Snyman 1996). The Allanridge Formation is andesitic overlying the Bothaville Formation conformably (Kent 1980).

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

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).

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.

Figure 5: Photograph of a stromatolite (E. Butler).

A very wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite 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).

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

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.

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.

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

KALAHARI (@k; @k1))			Gordonia (Qg);		Aeolian sand	Palynomorphs, root casts (rhizomorphs / rhizoliths) and burrows (eg termitaria), rare vertebrate remains (mammals, fish, ostrich egg shell etc), diatoms, freshwater stromatolites, freshwater and terrestrial shells (gastropods, bivalves), ostracods, charophytes	Fossils mainly associated with ancient pans, lakes and river systems Palaeontology poorly studied. Basal Late Cretaceous gravels and lacustrine clays probably fossiliferous (bones, teeth, petrified wood, palynomorphs) but v. rarely exposed.
			Qsi; Qa		Fluvial gravels, sands, lacustrine and pan mudrocks, diatomites and diatomaceous limestones, evaporites, consolidated to unconsolidated aeolian sands, pedocretes (especially calcrete) Late Cretaceous to Recent 90 Ma to 0 Ma		
			Lonely (Qlo)				
			Makolanen (@mo; @mo1; @mo2; @mo3)				
			Eden (Te; Te1; Te2; Te3; Te4; Te5; Te6; Te7; Te8)				
			Budin (Tbu; Tbu1)				
			T-Qc; Tl; T12				

	CHUNIESPOORT			Penge (Vp; Vla; Qd; Vda; Vk; Vpe)		Banded ironstone	Stromatolites	ALERT FOR POTENTIALLY FOSSILIFEROUS LATE CAENOZOIC CAVE BRECCIAS WITHIN "TRANSVAAL DOLOMITE" OUTCROP AREA (breccias not individually mapped)
		Malmani (Vm; Vma)		Mma; Vmm; Vmo; Vmo1; Vmo2; Vmf; Vme; Ve; Ve1; Vml; Va1; Va2; Va3; Vmd; Vm; Vc; Vb; Vf; Vfr; Vfr1; Vfr2; Ve; Vl; Vmo1; Vmo2; Vmo3; Vo; Voa		Stromatolitic carbonates (limestones / dolomites), minor secondary cherts, mudrocks including carbonaceous shales	Range of shallow marine to intertidal stromatolites (domes, columns etc), organic-walled microfossils	
				Black Reef (Vbr); Vryburg (Vv; Vvr; Vvr1; Vvk; Vvq)		Quartzite, conglomerate and shale. Stromatolitic carbonates	Stromatolites	
	SKILPADHEK (Vsk)					Conglomerate, basic and acid lava, tuff and quartzite	No fossils recorded	
VENTERSDORP (Rv; R)				Allanridge (R; Ra)		Basaltic lava and tuff	No fossils recorded	
				Bothaville (Rbt)		Quartzite, conglomerate and greywacke	No fossils recorded	
	PLATBERG (Rp)			Ra; Rb; Rm; Rma; Rgb; Rka; Rkm; Rka1; Rka2		Basic and acid volcanics with subordinate siliciclastic sediments (breccias, conglomerates, sandstones, mudrocks), with minor limestones and cherts in upper part of succession Late Archaean Randian 2.7-2.5	Lacustrine stromatolites and possible microfossils	Stromatolites and possible microfossils recorded from sediments of Platberg Group elsewhere (Northern Free State) and therefore might also be present in North West Province
				Rietgat (Rr; Rrg; Rrg2)		Predominantly lavas with minor metasediments (fluvial and lacustrine conglomerates, breccias, minor shales, stromatolitic carbonates, cherts)	Lacustrine stromatolites reported in carbonates,of Rietgat Formation (Platberg Group); possible organic-walled microfossils in cherts. LIP (Large Igneous Province) with voluminous eruptions of basaltic and other lavas.	Stromatolites recorded from borehole cores. Any surface occurrences would be of considerable interest.
				Rm; Rgb; Rkm			Possible stromatolites	
	KLIPRIVIERSBERG (Rk)			Rk; Ral; Rmk		Basic and acid volcanics with subordinate siliciclastic sediments	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**.

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

Rock Unit	Significance/vulnerability	Recommended Action
Tertiary - Quaternary	**Moderate**	Desktop Study
Malmani Subgroup	**High**	Desktop Study and Phase 1: Field Assessment likely
Black Reef Formation	**Moderate**	Desktop Study
Ventersdorp Supergroup	**Low**	Desktop and Protocol for Chance Finds

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).

Impact: **MODERATE** There may be significant fossil resources that may be impacted by the development (shale/dolomite).

The project includes one locality Option (Figure 2) with the above impact.
Option 1: Two roughly rectangular areas outlined in yellow with the R 49 Road and the Slurry railway station to the north; the R 503 Road and Mafikeng to the west; and Zeerest to the far north north-east. The area is approximately 30 ha in size.

H. Description of the Methodology (1e)
The palaeontological impact assessment desktop study was undertaken in March 2021 during the official covid-19 lockdown. A Phase 1: Field Study includes 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.

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 -

> Act No. 25 of 1999. National Heritage Resources Act, 1999.
> The National Estate as: 3 (2) (f) archaeological and palaeontological sites, (i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,
> Heritage assessment criteria and grading used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;
> (b) Grade 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

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.

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).

All of the formations in the development area may contain stromatolites.

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 may be necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is **MODERATE** with a Phase 2 Palaeontological Mitigation is when 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: One locality Option is presented and possible (see Executive Summary).
d. The following should be conserved: if any palaeontological material is exposed during clearing, digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed, and a palaeontologist should be called in to determine proper mitigation measures.
e. Consultation with parties was not necessary.
f. This report must be submitted to SAHRA together with the Heritage Impact Assessment.

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 Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by Coastal Environmental Services.
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) (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.

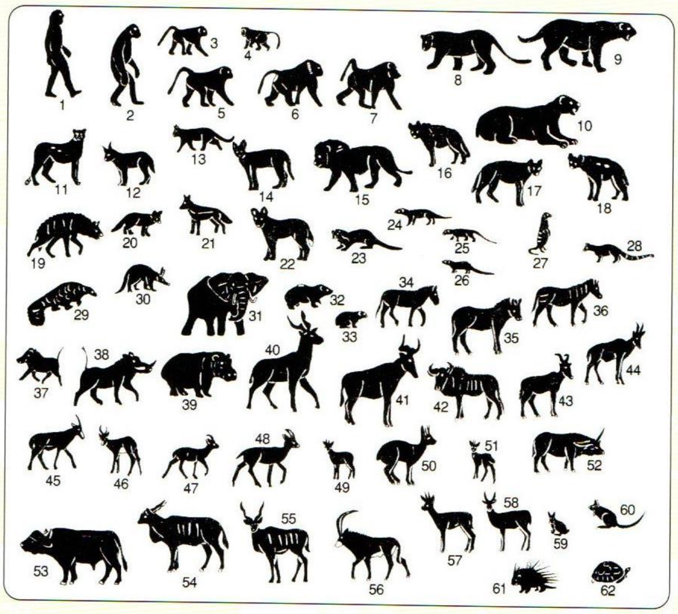
I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

It may be possible that the Palaeontolgical Impact Assessment 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
2021/03/07

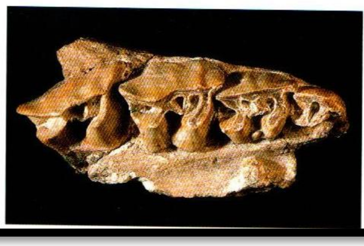
Appendix 1: Fossils occurring in both the Quaternary and Tertiary.



Silhouette representation of the larger vertebrates whose remains are represented in Members 1-3 of the Swartkrans site on the outskirts of the town of Krugersdorp. Numbers after each taxon comprise minimum numbers of individuals represented in the remains of the lower bank (Member 1), hanging remnant (Member 1), Member 2 and Member 3 respectively.
Courtesy of Dr C.K. Brain.
Museum of Natural History, Pretoria

FAUNA FROM MEMBERS 1 - 3, SWARTKRANS (Makapanian Mammal Age)
Courtesy Dr B. Brain, - Museum of Natural History, Pretoria

1: *Homo erectus* (man) 1,3,2,0. **2**: *Australopithecus robustus* (robust apeman) 13,87,17,9. **3**: *Parapapio jonesi* 0,8,0,0. **4**: *Cercopithecoides* sp. 1,0,0,0. **5**: *Papio hamadyryas robinsoni* 6,38,8,11. **6**: *Theropithecus oswaldi danieli* 1,17,1,14. **7**: *Dinopithecus ingens* 1,26,0,0. **8**: *Panthera pardus* (leopard) 4,12,2,5. **9**: *Dinofelis* sp. (false sabre-toothed cat) 0,1,0,0. **10**: *Megantthereon* sp. (dirk-toothed cat) 0,1,0,1. **11**: *Acinonyx jubatus* (cheetah) 0,1,0,1. **12**: *Felis caracal* (caracal) 1,0,0,0. **13**: *Felis lybica* (African wild cat) 0,0,0,1. **14**: *Felis serval* (serval) 1,0,0,0. **15**: *Panthera leo* (lion) 1,1,0,0. **16**: *Hyaena brunnea* (brown hyaena) 1,4,2,3. **17**: *Chasmaporthetes nitidula* (hunting hyaena) 2,8,1,2. **18**:*Crocuta crocuta* (spotted hyaena) 0,2,1,1. **19**: *Proteles* sp. (large fossil aardwolf) 1,1,0,1. **20**: *Vulpes* sp. (fox) 0,2,0,3. **21**: *Canis mesomelas* (black-backed jackal) 3,4,4,5. **22**: Large canid gen. and sp. indet. 0,0,1,1. **23**: *Aonyx capensis* (Cape clawless otter) 2,0,1,2. **24**: *Atilax* sp. (water mongoose) 0,0,1,1. **25**: *Cynictis penicillata* (yellow mongoose) 0,0,1,1. **26**: *Herpestes ichneumon* (large grey mongoose) 1,0,0,0. **27**: *Suricata suricatta* (suricate) 0,0,2,1. **28**: *Genetta tigrina* (large-spotted genet) 0,0,0,1. **29**: *Manis* sp. (pangolin) 0,0,0,1. **30**: *Orycteropus afer* (antbear) 1,0,1,1. **31**: cf. *Elphas* sp. 2,0,0,1. **32**: *Procavia transvaalensis* (large fossil dassie) 3,8,3,5. **33**: *Procavia antiqua* (fossil dassie) 17,16,10,11. **34**: *Hipparion lybicum steytleri* (three-toed horse) 1,1,1,1. **35**: *Equus capensis* (giant Cape horse) 2,6,3,5. **36**: *Equus burchelli* (Burchell's zebra) 0,0,0,1. **37**: *Phacochoerus* sp. (warthog) 1,0,3,1. **38**: cf. *Tapinochoerus meadowsi* (large fossil pig) 1,7,1,1. **39**: *Hippopotamus* sp. (hippopotamus) 1,0,0,1. **40**: Giraffid 0,1,1,1. **41**: *Megalotragus* sp. (giant hartebeest) 0,3,1,3. **42**: *Connochaetes* sp. (wildebeest) 7,19,7,7. **43**: Medium alcelaphine: *Alcelaphus* sp. or *Beatragus* sp. (hartebeest) 3,22,3,6. **44**: *Rabaticerus porrocornutus* 0,2,0,0. **45**: *Damaliscus* sp. (blesbok) 2,4,6,6. **46**: *Antidorcas marsupialis australis* (springbok) 11,0,10,18. **47**: *Antidorcas recki* 0,6,2,1. **48**: cf. *Gazella* sp. (gazelle) 5,6,5,14. **49**: *Oreotragus oreotragus* (klipspringer) 1,0,0,1. **50**: *Oreotragus major* (fossil klipspringer) 0,1,0,0. **51**: *Raphicerus campestris* (steenbok) 1,0,1,3. **52**: *Makapania* sp. (musk ox) 0,3,0,0. **53**: *Syncerus* sp. (buffalo) 2,3,2,3. **54**: *Taurotragus oryx* (eland) 0,0,1,1. **55**: *Tragelaphus strepsiceros* (kudu) 0,4,0,1. **56**: *Hippotragus* cf. *niger* (sable) 0,0,1,3. **57**: *Pelea* sp. (rhebok) 0,2,0,2. **58**: *Redunca arundinum* (reedbuck) 0,1,0,0. **59**: Lagomorph gen. and sp. indet. (hare) 9,0,4,7. **60**: *Pedetes* sp. (springhare) 1,0,1,1. **61**: *Hystrix africaeaustralis* (porcupine) 2,2,1,2. **62**: *Chelonia* indet. (tortoise) 1,0,2,2.



Left: Teeth of the white rhino *Ceratotherium simum* from Makapansgat. **Right**: View from above shows the sharp cutting edges of the tooth row of this predominant grazer. Specimen 170 mm long.
In the collection of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Johannesburg.
Photograph C.S. MacRae

Appendix 2 (**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 may be asked to survey the areas affected by the development and indicate on plan where the construction / development will take place. Trenches may 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.