Richbay, Vosloorus Filling Plant

Ekurhuleni Metropolitan Municipality, Gauteng Province.

Farm: Portion 86 of Vlakplaats 138-IR

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 942 0110 x 1057

Palaeontological Impact Assessment: Phase 1: Field Study

Commissioned by: WSP, Environment & Energy, Africa

Building C, 33 Sloane Street,

Bryanston,

2191

011 300 6089

Ref: Pending

2020/02/14

B. Executive summary

Outline of the development project: WSP, Environment & Energy, Africa has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Phase 1: Field Study of the suitability of the proposed Richbay, Vosloorus Filling Plant on Portion 86 of the Farm Vlakplaats 138-IR, Ekurhuleni Metropolitan Municipality within the Gauteng Province.

The applicant, Richbay Chemicals (Pty) Ltd proposes to establish a filling plant. The plant will be commissioned in 4 Stages during which operational activities will be undertaken.

The Project includes one Alternative (Figure 1):
Alternative 1: A rectangular area outlined in red situated in Vosloorus with the N3 National Road to the west, Waterland Road to the east and Pelser Road to the north. The size of the site is approximately 8.34 hectares.

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.

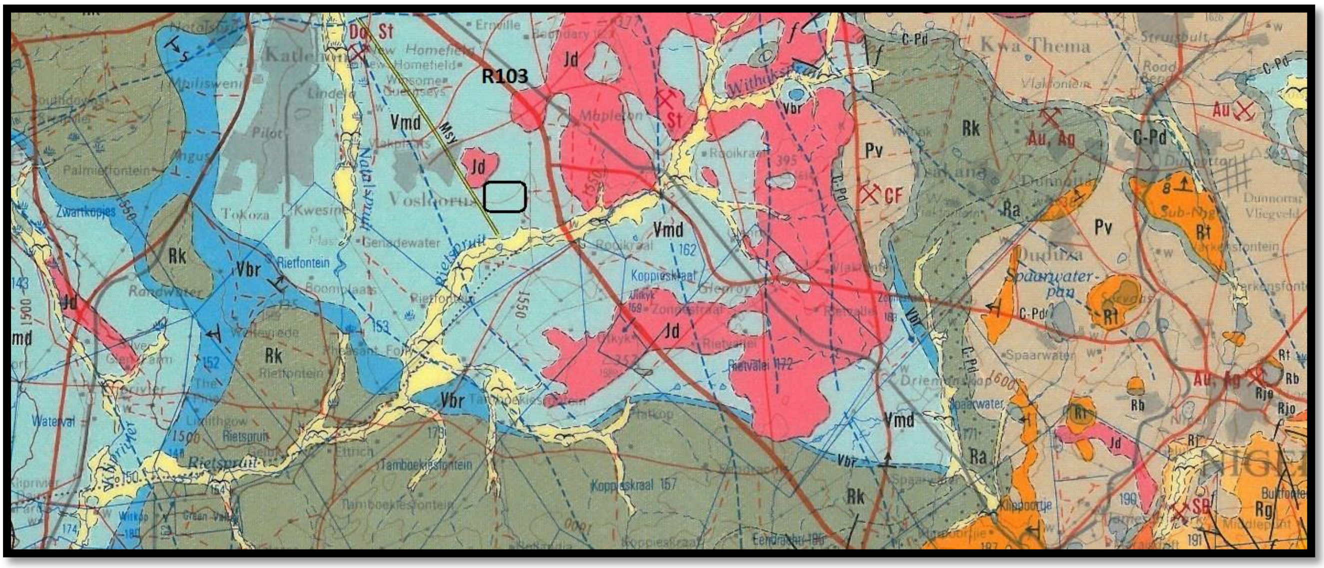
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
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 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 1:250 000, 2626 Wes Rand (Keyser *et al.* 1986).

Figure 3: The geology of the development area.



Legend to map and short explanation.
m – Alluvium (yellow). Quaternary.
Jd – Dolerite (pink).
Vmd – Dolomite, chert [=] (blue), Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup. Vaalian.
…… – (blue) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
┴5 – Strike and dip of bed.
□ – Proposed development (in black on figure).

Summary of findings (**1d**): The Phase 1: Field Study was undertaken in October 2019 in the summer in hot and dry conditions and the following is reported.

Permian sediments are extensively intruded and thermally metamorphosed (baked) by subhorizontal sills and steeply inclined dykes of the Karoo Dolerite Suite (Jd). These early Jurassic (183 Ma) basic intrusions baked the adjacent mudrocks and sandstones to form splintery hornfels and quartzites respectively. Thermal metamorphism by dolerite intrusions tends to reduce the palaeontological heritage potential of the adjacent sediments.

The Chuniespoort Group (Vmd) 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 is 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.

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

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.

Field Observation – The area is very disturbed, there are several chert piles stacked near the perimeter fence. The surface is covered with gravel and a house and several other buildings are present. A sand-blasting industry is currently operative. Livestock are also present. Only chert can be found on the surface.

Recommendation:
The potential impact of the development on fossil heritage is **HIGH**, therefore a field survey or further mitigation or conservation measures were necessary for this project (according to SAHRA protocol). A Phase 2 PIA and or mitigation are recommended if fossils are found during construction or the Phase 1: Field Study.

The development will benefit the community, industries and businesses. Only one Alternative is proposed. The development will be situated on the Malmani Subgroup and does not encroach on any Quaternary sands.

The Project includes one Alternative (Figure 2):
Alternative 1: A rectangular area outlined in red situated in Vosloorus with the N3 National Road to the west, Waterland Road to the east and Pelser Road to the north. The size of the site is approximately 8.34 hectares.

Concerns/threats (**1g,1ni,1nii,1o,1p**) to be added to the EMPr/Chance Find Protocol:

1. Threats are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic, and human disturbance.
2. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden as this study may have missed a fossiliferous outcrop. An appropriate Protocol and Management plan is attached for the Environmental Control Officer (Appendix 2).
3. Care must be taken during the dolomite risk assessment according to SANS 1936-1 (2012) as stromatolites may be present.

The recommendations are:

1. Mitigation may be needed (Appendix 2) if fossils are found.

2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formation present and its fossils and obtain training pre-construction (one day).
3. The development may go ahead.
4. The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities. For a chance fossil find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist (pre-construction training of ECO) and the ECO must visit and survey site after blasting and excavating or drilling.
5. A palaeontologist must visit site once excavations are completed in order to survey excavations and material.

   Stakeholders: Developer – Richbay Chemicals (Pty) Ltd., 63/65 Ceramic Curve, Alton, Richards Bay, 3900.
   Environmental – WSP, Environment & Energy, Africa, Building C, 33 Sloane Street, Bryanston, 2191, 011 300 6089.
   Landowner – Bulldog Project (Pty) Ltd., 22 Pansy Street, Winchester Hills, Extension 3.

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 3). It is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, Guidelines 2012.

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.

Richbay proposes to establish a filling plant. The plant will be commissioned in 4 Stages during which the following operational activities will be undertaken:

Phase 1: Filling Plant -
During Phase 1 of the development, a filling plant will be constructed. Various chemicals will be brought in and decanted from bulk tankers to medium sized packages sizes. The packed products are transferred to the warehouse and shifted to be delivered or shipped to customers. Palletizing and strapping might be required. No manufacturing will be undertaken during this phase. Chemicals to be decanted in the filling plant include:

- Water Purification Chemicals: (Hydrochloric Acid; Sulphuric Acid; Sodium Hypochlorite; Caustic Soda; Ferric Chloride; Sodium Chlorite Liquid and Sodium Metabisulphite);
- Nitric Acid;
- Formalin;
- SLES70%;
- Sulphonic Acid (LABSA);
- Soda Ash;
- Potassium Hydroxide Liquid; and
- Phosphoric Acid.

It is estimated that at full filling production, the plant will have a maximum of 2000MT – 2500MT combined storage capacity of all bulk tanks and small tanks.

Phase 2: Acid Regeneration Plant –
Phase 2 will include the construction of an acid regeneration plant for the reprocessing of waste HCL into Ferric Chloride and a small portion of Calcium Chloride at the acid regeneration plant. The process is detailed below:

- Waste Acid will be received from the galvanizing plants;
- The product will go through an iron exchange process;
- The product will then be strengthened with Hydrochloric Acid (which is already on site in the phase 1 filling plant) design;
- The product will then be put through an evaporation process (with the use of paraffin fuelled boiler) that will take place to increase the percentage of Ferric from approximately 30% to 40-44%;
- Ferric Chloride will be stored in Bulk Tanks and then decanted in to smaller pack sizes or bulk road tankers for the market;
- Waste Zinc Chloride will be sold into the market as a dust suppressor currently used or in waste processes requiring Zinc Chloride.

Phase 3: Manufacturing of Caustic Soda -
During Phase 3 Caustic Soda Flakes will be generated from Caustic Soda Lye in a dry evaporation process/drying process that uses up about 50% to 99% of the Caustic Lye. Approximately 50-60MT of caustic lye will be used to produce an estimated 25MT dry tons of caustic soda per day.

Phase 4: Solvent Filling Plant -
This phase will also include the construction of a solvent filling plant. Products will be decanted from bulk storage tanks to medium tanks and then smaller package sizes if required. The packed product is transferred to the warehouse and shifted to be delivered or shipped to customers. Palletizing and strapping might be required. A list of solvent chemicals to be stored and decanted is provided below:

— Methanol;
— Thinners;
— Paraffin;
— Shelsol A;
— Benzine;
— Toluene; and
— Acetone.

Richbay has existing chemical filling plants in South Africa, however in order to be closer to the northern market in South Africa a filling plant is required in Gauteng. The site in Gauteng is centrally located and in close proximity to the major routes in the Province.

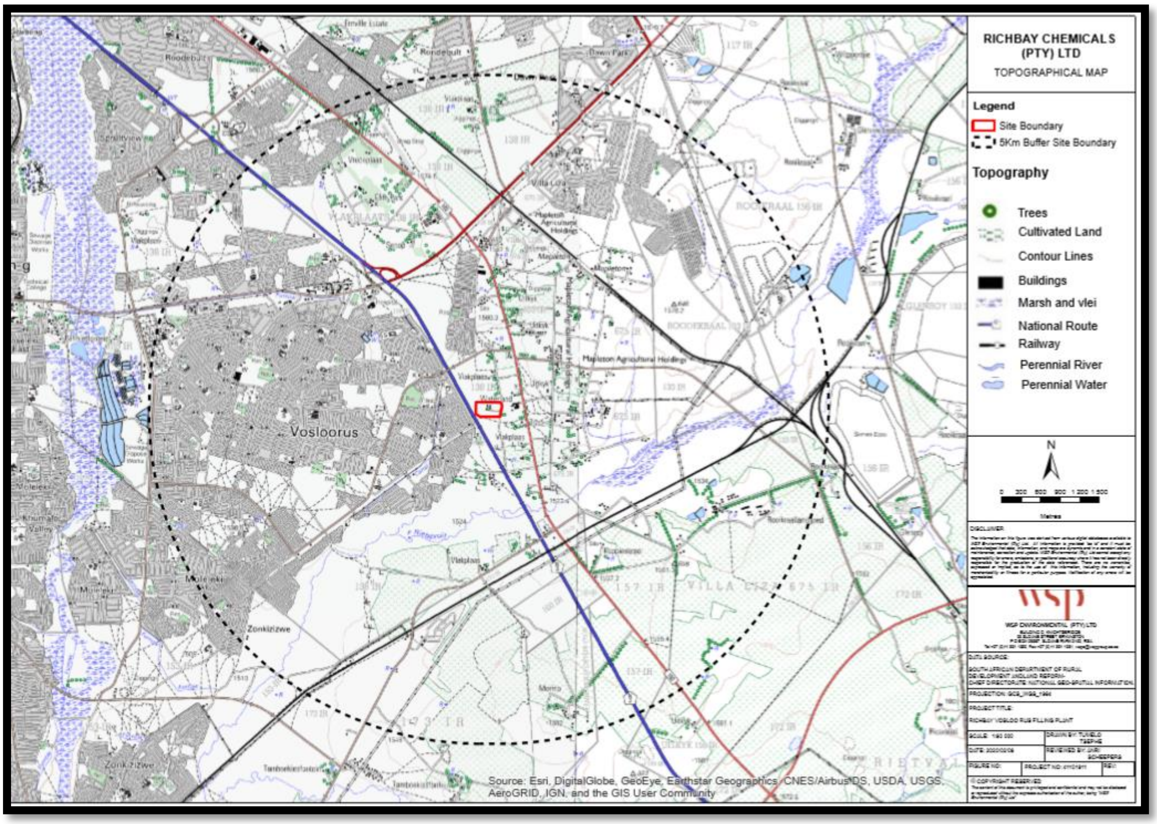
Ferric Chloride is produced in a wide range of applications in the industrial sector including surface water clarification, heavy metal precipitation, industrial effluent treatment and phosphate precipitation in sewage treatment. Currently there is only one company in the country that produce and supplies Ferric Chloride to South Africa and other neighbouring countries. This serves as a motivation for Richbay to increase the supply of the product, particularly to the neighbouring countries located further north of the country and a great distance away from the existing supplier. This therefore entails that the Filling Plant located in Vosloorus, will have a competitive advantage owing to the shorter distance to be travelled to transport the product to these neighbouring countries.

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

Related infrastructure:

1. Weighbridge,
2. Dangerous Goods Warehouse,
3. Bulk dangerous goods storage tanks,
4. Acid Regeneration Plant,
5. Sewage Lines,
6. Power Lines,
7. Pond,
8. Parking area, and
9. Administrative office.

Figure 1: Development location (WSP)



The Project includes one Alternative (Figure 2):

Alternative 1: A rectangular area outlined in red situated in Vosloorus with the N3 National Road to the west, Waterland Road to the east and Pelser Road to the north. The size of the site is approximately 8.34 hectares.

Rezoning/ and or subdivision of land: Industrial 2.

Name of developer and consultant: Richbay Chemicals (Pty) Ltd and WSP, Environment & Energy, Africa.

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

Short *Curriculum vitae:* 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 invertebrate, plant, dinosaur, Therapsid, amphibia and reptile collections. For the past 13 years she carried out field work in the Eastern Cape, Western Cape, Northern Cape, North West, Free State, Gauteng, Limpopo, Mpumalanga and Kwazulu Natal Provinces and has done more than 200 PIA's since 2012. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 25 years.

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

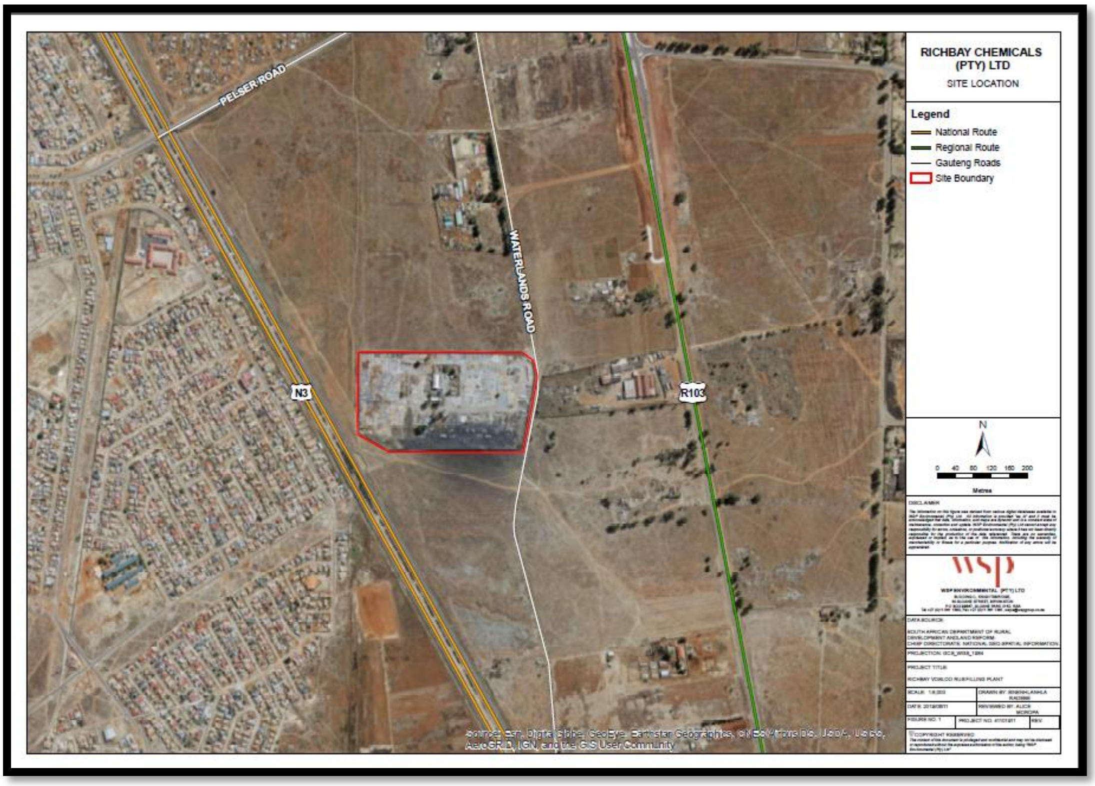
E. Description of property or affected environment

Location and depth:

The proposed Richbay, Vosloorus Filling Plant will be located on Portion 86 of the Farm Vlakplaats 138-IR, Ekurhuleni Metropolitan Municipality within the Gauteng Province.

Depth is determined by the infrastructure to be developed and the thickness of the formation in the development area, in this instance the related infrastructure. 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.

Figure 2: Location map of proposed infrastructure (WSP).



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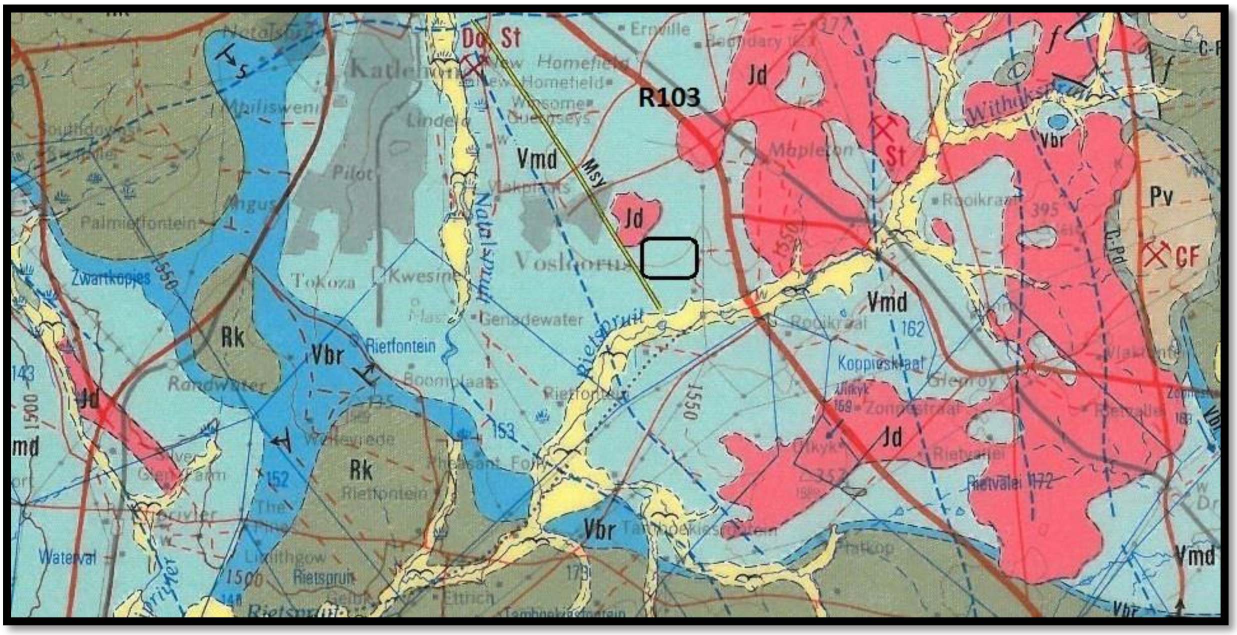
F. Description of the Geological Setting

<u>Description of the rock units:</u>

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).

Figure 3: Excerpt of 1:250 000 Geological Map 2626 Wes Rand (Keyser *et al.* 1986).



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M – Alluvium (yellow). Quaternary.

Jd – Dolerite (pink).

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

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

------ - Concealed geological boundary.

⊥5 – Strike and dip of bed.

□ – Proposed development (in black on figure).

Mining Activities on Figure:

Do – Dolomite CF – Plastic Fire-clay St - Aggregate

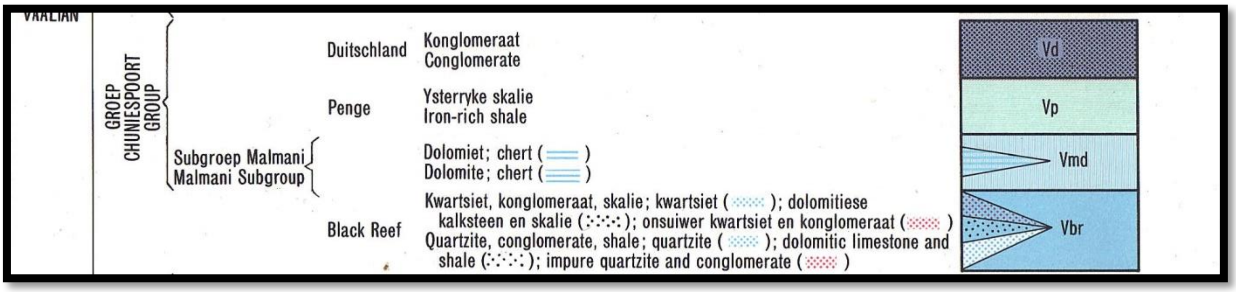
Mining past and present has no influence on the development.

Permian sediments are extensively intruded and thermally metamorphosed (baked) by subhorizontal sills and steeply inclined dykes of the Karoo Dolerite Suite (Jd). These early Jurassic (183 Ma) basic intrusions baked the adjacent mudrocks and sandstones to form splintery hornfels and quartzites respectively. Thermal metamorphism by dolerite intrusions tends to reduce the palaeontological heritage potential of the adjacent sediments.

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 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 is 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.

Figure 4: Lithostratigraphy (Keyser 1986).



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Field Observation – The area is very disturbed, there are several chert piles stacked near the perimeter fence. The surface is covered with gravel and a house and several other buildings are present. A sand-blasting industry is currently operative. Livestock are also present. Only chert can be found on the surface.

Figure 5: View of the property with livestock.

Figure 6: View of property showing buildings also showing gravel on surface.

Figure 7: View towards gate and site office.

Figure 8: *In situ* chert.

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).

The project area lies on the East Rand of the Gauteng Province. The oldest rocks here known as the Witwatersrand Supergroup has examples of cyanobacteria. Stromatolites occur throughout the Transvaal Supergroup. Overlying the Transvaal Supergroup are the rocks of the Karoo Supergroup known for fossil plants, invertebrates and the trace fossils from the Ecca and Dwyka beds.

The Cenozoic Era, in which we are presently living, is popularly known as the 'Age of the Mammals'. Its fossils are preserved on the river gravel terraces (Cornelia), cave systems (Makapan), coastal plains (Langebaanweg), and basins. The Cenozoic Era of South Africa has been subdivided into six African Land Mammal Ages, namely, Recent, Florisian, Cornelian, Makapanian, Langebaanian, and Namibian (MacRae 1999).

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 enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

The Quaternary deposits are covered by the Heritage Impact Assessment and if fossils are present these should be studied by an archaeozoologist as they do faunal lists through identification of individual skeletal elements. Groenewald and Groenewald 2014 described these as alluvial deposits associated with recent water courses of main rivers and streams. These sediments are presently not well studied and records of fossil occurrences are mainly associated with archaeological reports. The floodplains are protected by the 1:100 and 1:50 year flood lines that cannot be intruded during construction, except for roads, services and parking areas.

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 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.

Cyanobacteria have been described from the gold bearing conglomerates of the Witwatersrand Supergroup (MacRae 1999). These are significant recordings as it gives a possible indication of very early life forms, possibly ancient lichens that existed up to 2900 million years ago. These structures are for example associated with the Carbon Leader Seam in the Carletonville Goldfield, with native gold visible to the naked eye. Very large stromatolites can be found in the Campbell Rand Subgroup in the North West Province (Groenewald and Groenewald 2014).

Figure 9: Example of a stromatolite present in dolomite (Photograph: E. Butler).

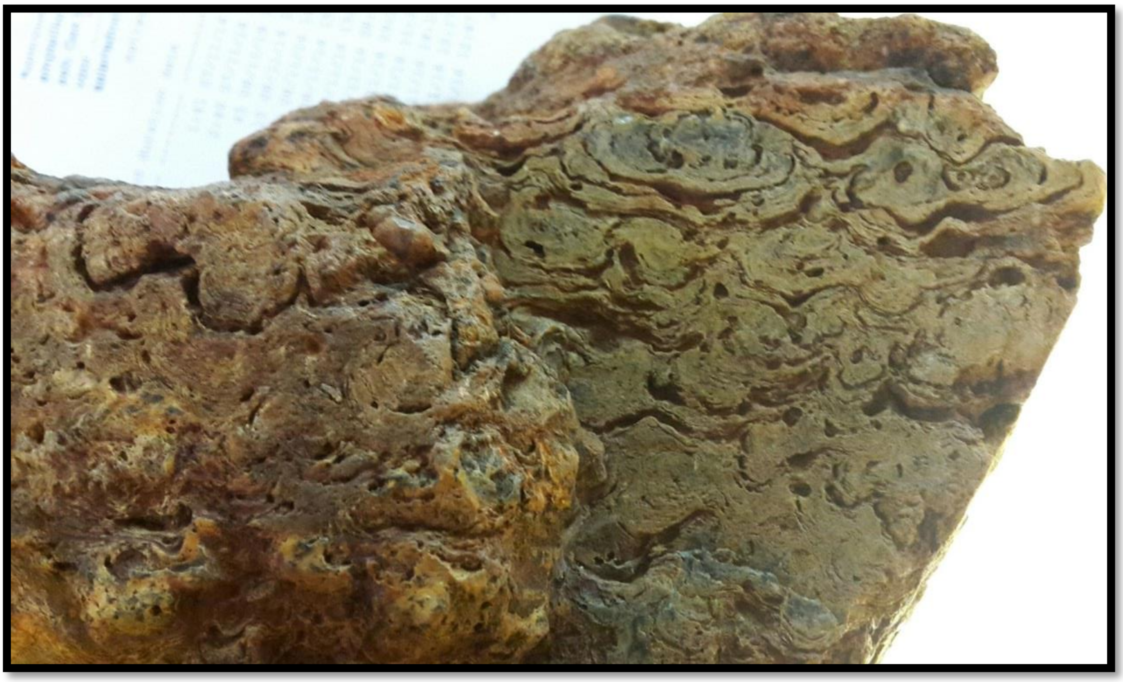

Table 1: Taken form The Palaeotechnical Report (Groenewald and Groenewald 2014).

CHUNIESPOORT		Duitschland (Vd)		Conglomerate	No fossils recorded	Good examples of stromatolites in Cradle of Humankind region
		Penge (Vp)		Iron-rich shale	Stromatolites	
	Malmani (Vm; Vmd; Vma)			Stromatolitic carbonates (limestones / dolomites), minor secondary cherts, mudrocks including carbonaceous shales	Range of shallow marine to intertidal stromatolites (domes, columns etc), organic-walled microfossils	ALERT FOR POTENTIALLY FOSSILIFEROUS LATE CAENOZOIC CAVE BRECCIAS WITHIN "TRANSVAAL DOLOMITE" OUTCROP AREA (breccias not individually mapped)
		Black Reef (Vbr)		Siliciclastic sediments (mature sandstones plus minor mudrocks, conglomerates) deposited during a fluvial to shallow marine transition	Possible equivalent of Black Reef Fm in N. Cape (Vryburg Formation) contains stromatolitic carbonates	

Legend:

***Orange** – High palaeontological sensitivity*

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 is generally **LOW to VERY HIGH**, but here locally **HIGH** for the Malmani Subgroup.

Rock Unit	**Significance/vulnerability**	**Recommended Action**
Malmani Subgroup	High	Desktop study and field assessment is likely
Jd	Very Low	No action required

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

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

Impact: **HIGH** for the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup. There are significant fossil resources that may be impacted by the development.

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in October 2019. A field assessment includes a walkthrough 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 this study relied on literature, geological maps, google.maps, and google.earth images.

SAHRA Document 7/6/9/2/1 only 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 assess more recent quaternary and tertiary deposits.

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

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

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. 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 (1f)

The Malmani dolomites occur in the project area, therefore stromatolites may be present.

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 enrichment in the amount of oxygen in the atmosphere. 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 enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

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.

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, activities, the sealing-in or destruction of fossils by development, vehicle traffic, mining and prospecting (not this project), and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1j,1l)

a. There is no objection (see Recommendation B) to the development, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field Study as fossils may be present as the palaeontological sensitivity is **HIGH.** A Phase 2 Palaeontological Mitigation is generally required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during construction. The Protocol for a Chance Find 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: Only one Alternative is presented (see Executive Summary).

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed, and a palaeontologist should be called in to determine proper mitigation measures. A palaeontologist should visit the site once the excavations are done to inspect site, material excavated should not be removed (hard rock) from site.

Sampling and collecting **(1m,1k)**:
Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: 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 WSP.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped, a 30 m no-go barrier constructed and a palaeontologist should be called in to determine proper mitigation measures, especially for shallow caves.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment (fossils) and adjacent areas as well as for safety and security reasons.

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Declaration (disclaimer) 1(b)

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

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

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

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

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Heidi Fourie
2020/01/14

Appendix 1 (1k,1m,1q): **Protocol for Chance Finds and Management plan**

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

- When a fossil is found, 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.
- Fossils unearthed must be put in a safe place.
- The ECO should familiarise him- or herself with the fossiliferous formations and its fossils. A site visit after blasting, drilling or excavating is recommended and the keeping of a photographic record when feasible.
- The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Fossils.

The developer must survey the areas affected by the development and indicate on plan where the construction / development will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological layers / formations. 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. Fossils likely to occur can be for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as **VERY HIGH** or **HIGH**) or for example invertebrates from the Volksrust Formation as an example (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once a week).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company (if applicable) must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

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

SAHRA Documents:
Guidelines to Palaeontological Permitting Policy.

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

Appendix 2: Table of Appendix 6 requirements. (The points are bracketed and in bold in text)

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

Appendix 4: Final Prospecting Plan