

Proposed Development of the Greenies Farm Aquaculture in Jericho, North West
Madibeng Local Municipality, Bojanala District Municipality, North West Province.

Farm: Farm 227 Portion 0 and 1

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Palaeontological Impact Assessment: Phase 1 Field Study

Facilitated by: IDS Geographical Information Systems and Environmental Consulting Services

P.O. Box 689,

Rivonia, 2128,

Tel: 087 353 2576

2021/10/25

Ref: Pending

SAHRA CaseID: 16353



Plant fossil - Ecca Group (P)



B. Executive summary

Outline of the development project: Information Decision Systems (IDS) 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 Development of the Greenies Farm Aquaculture in Jericho, North West in the Madibeng Local Municipality, Bojanala District Municipality, North West Province on Farm 227 Portion 0 and 1.

The applicant, TBC (Pty) Ltd intends to develop an aquaculture facility in order to provide vegetables and other forms of agriculture.

The Project includes one locality Option (see Figure 2):

Option 1: An area outlined with structures indicated in different colours and labelled. Brits is 32 km to the south-west and Jericho is 50 m to the south. A river is present on the east. The approximate size of the site is 4 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.

“palaeontological” means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.

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

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

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

(i) 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 (Appendix 6, 1c) 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 2526 Rustenburg (Walraven 1981), 1:250 000 geological maps.

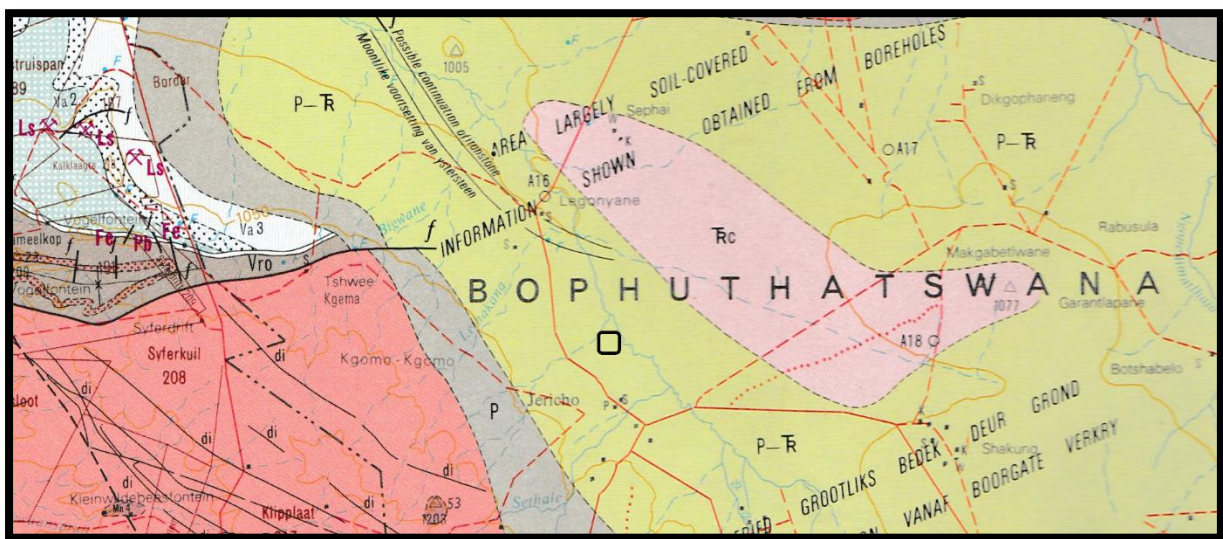


Figure: The geology of the development area.

Legend to Figure and short explanation.

- P-RT – Mudstone, siltstone, marl, sandstone and grit (green). Irrigasie Formasie, Karoo Supergroup. Trias.
- P – Sandstone, shale, grit and conglomerate near base, coal seams (grey). Ecca Group, Karoo Supergroup. Permian.
- – (black) Lineament (Possible dyke).
- f-- Fault.
- ⊥5° - Strike and dip.
- – Approximate position of farm (blocked in black).

The Irrigasie Formation (P-Rt) of the Karoo Supergroup is Trias in age (±209 million years) and this basin is present in the Springbok Flats. The Irrigasie Formation is a succession of predominantly red mudstone lying between the Ecca Group and the Clarens Sandstone (Kent 1980). In this area, the Ecca Group forms the base. The red mudstone is interlayered with sandstone (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 Karoo Supergroup strata the palaeontological sensitivity can generally be **LOW** to **VERY HIGH**, and here locally in the development area **VERY HIGH** for the Irrigasie Formation (SG 2.2 SAHRA APMHOB, 2012).

The development will be situated on the Irrigasie Formation of the Karoo Supergroup which is usually fossiliferous. Conifers may be present often associated with ferns, cycads and cycadioides (Anderson 1999). It shows extensive bioturbation by trace fossils. Dinosaur fossils include the possible remains of 'Euskelosaurus' and *Gigantoscelis* (Groenewald & Groenewald 2014).

Summary of findings (1d): The Phase 1: Field Study was undertaken in October 2021 in the summer in dry and hot conditions during the official Covid-19 Level 1 lockdown, and the following is reported:

Field Observation: The walk through was done towards the middle of October 2021, conditions were hot and dry. Photographs show the fairly flat topography. A variety of soil types (overburden and topsoil) will be present. This project covers quite a large area, but it is accessible. Short grass, alien invasive species, bushes, and trees are present. Clearing, overgrazing, and ploughing are taking place. A gravel road cuts through the property. The river is present on the eastern side. No outcrops or fossils were found (Figures 5-11).

The Project includes one locality Option present on the **Irrigasie Formation**:

Option 1: An area outlined with structures indicated in different colours and labelled. Brits is 32 km to the south-west and Jericho is 50 m to the south. A river is present on the east. The approximate size of the site is 4 hectares.

Recommendation:

The potential impact of the development on fossil heritage is **VERY HIGH** and therefore a field survey was necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment: Field Study was done. A Phase 2: Mitigation will be recommended if the Phase 1: Field Study finds fossils or if fossils are found during the development.

Concerns/threats **(1k,l,m)** to be added to EMPr:

1. Threats are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic, and human disturbance.
2. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers.

The recommendations are **(1g)**:

1. Mitigation will be needed if fossils are found during the development.
2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formations present and its fossils and follow protocol.
3. The development may go ahead with caution.
4. The ECO must survey for fossils before and or after clearing, blasting, drilling or excavating and keep a photographic record of observations.
5. 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.

Stakeholders: Developer – Greenies Farm (Pty) Ltd. 97 Star Café Street, Jericho, 0189.

Environmental – Information Decision Systems. P.O. Box 689, Rivonia, 2128. Tel: 087 353 2576.

Landowner – Bakwena ba Mogopa tribal authority. Stand No. 0499, Moseja Section, Bethanie, 0270.

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D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R326 of 7 April 2017) of the Environmental Impact Assessment Regulations (see Appendix 2). It also is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, SAHRA, APMHOB, Guidelines 2012, Pg 1-15 (2).

Outline of development

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

The applicant, TBC (Pty) Ltd intends to develop an aquaculture facility in order to provide vegetables and other forms of agriculture.

Greenies Farm aims to establish an agri-business through the development of aquaponics (a combination of aquaculture and hydroponics). Production will be based on Recirculating Aquaculture System (RAS) (Figure 5). Water flows between aquaculture fish tanks and plant growing beds in a reticulated and closed system. The fish waste in the water is a key ingredient in the supplying of nutrients to the plant, enabling an unnecessary need for fertilisers, advancing organic fresh produce. The symbiotic relationship is such that fish waste provides nutrients, while the plants clean the water to remove all the harmful ammonia produced by the fish. Further supplements will be done such as aeration to ensure oxygen levels in the water. The facility will grow 100tons of Nile Tilapia and estimated 600tons of vegetables.

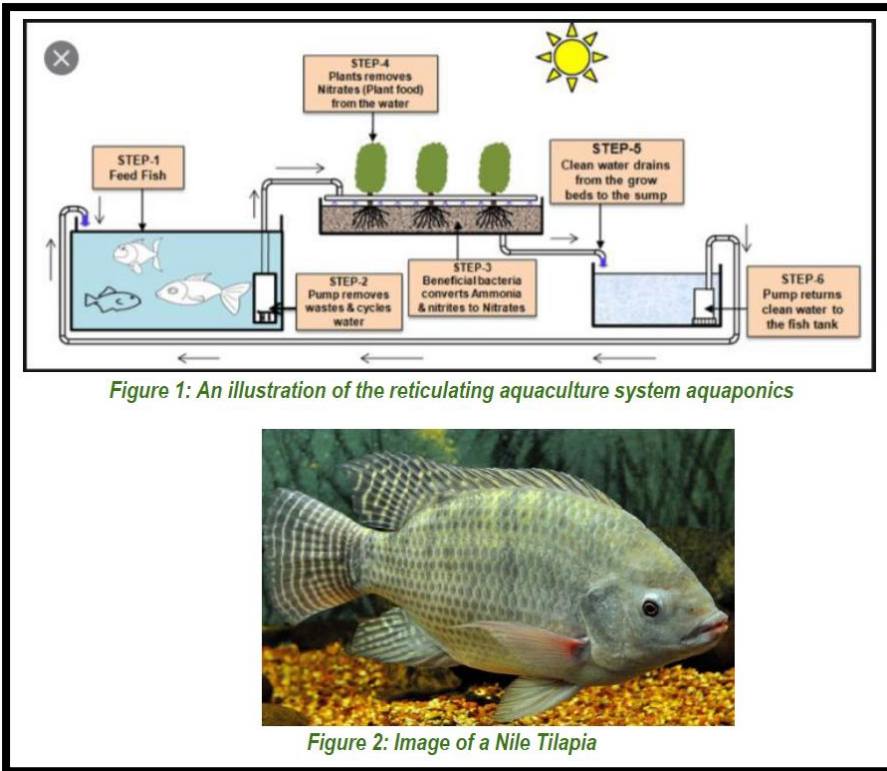


Figure 1a: Flow diagram of aquaponics and image of fish (IDS).

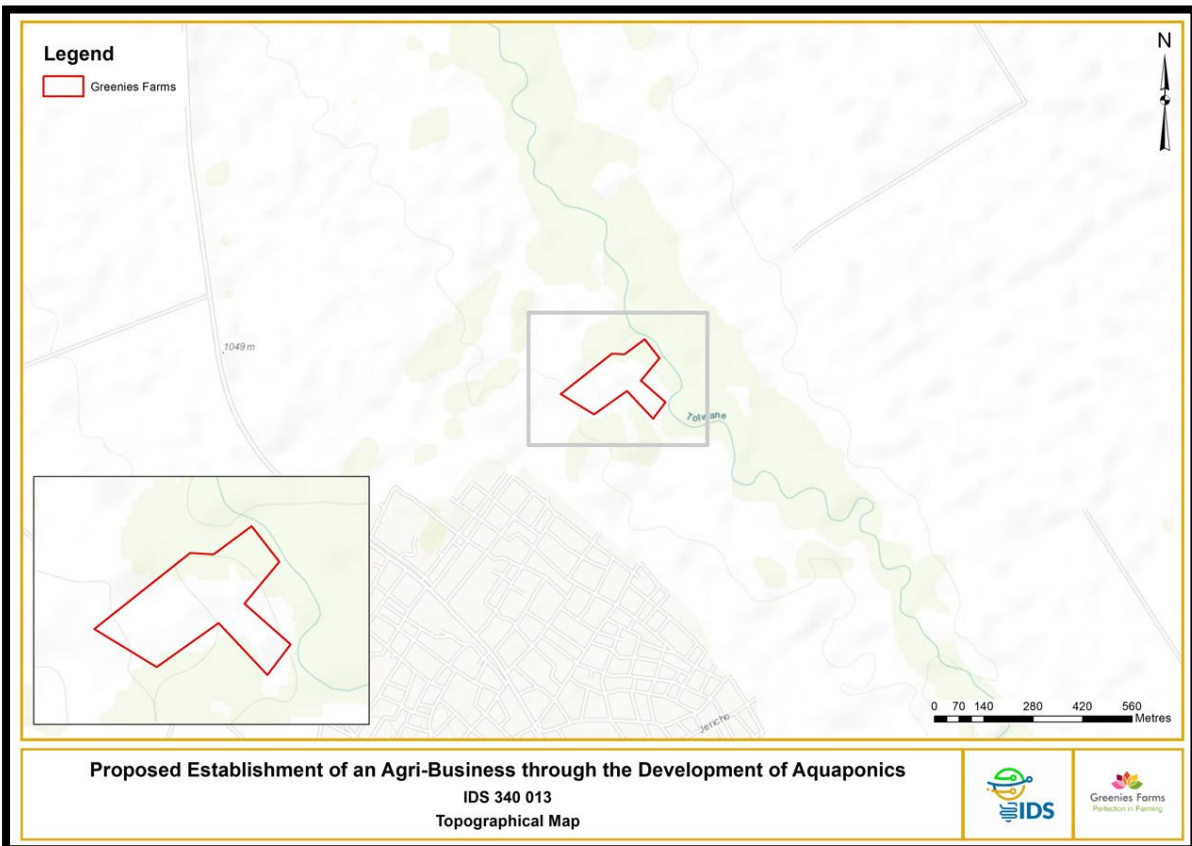


Figure 1b: Topographic section showing location (IDS).

Related Infrastructure:

1. Tilapia System – Phase 1
2. Piggery – Phase 2
3. Poultry
4. Nursery
5. Snail Greenhouse
6. BSF Greenhouse
7. Duckweed Greenhouse
8. Brick and Mortar House
9. Generators
10. Biodigester
11. Oxygen Plant
12. Concrete Compost Area
13. Staff Toilets
14. Access Roads
15. Entrances

This project may benefit the community, will create short- and long-term employment, the life expectancy of the community, revenue generation, skills transfer and training, the growth of the community and social development in general.

The Project includes one locality Option (see Figure 2):

Option 1: An area outlined with structures indicated in different colours and labelled. Brits is 32 km to the south-west and Jericho is 50 m to the south. A river is present on the east. The approximate size of the site is 4 hectares.

Rezoning/ and or subdivision of land: No. Agriculture.

Name of Developer and Consultant: Greenies Farm (Pty) Ltd and IDS.

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 (1ai,aii): 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. At present she is curator of a large fossil invertebrate collection, Therapsids, dinosaurs, amphibia, fish, reptiles, and plants at Ditsong: National Museum of Natural History. For the past 14 years she carried out field work in the North West, Western Cape, Northern Cape, Eastern Cape, Limpopo, Mpumalanga, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 26 years.

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

E. Description of property or affected environment

Location and depth:

The Proposed Development of the Greenies Farm Aquaculture in Jericho, North West in the Madibeng Local Municipality, Bojanala District Municipality, North West Province will be situated on Farm 227 Portion 0 and 1.

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.

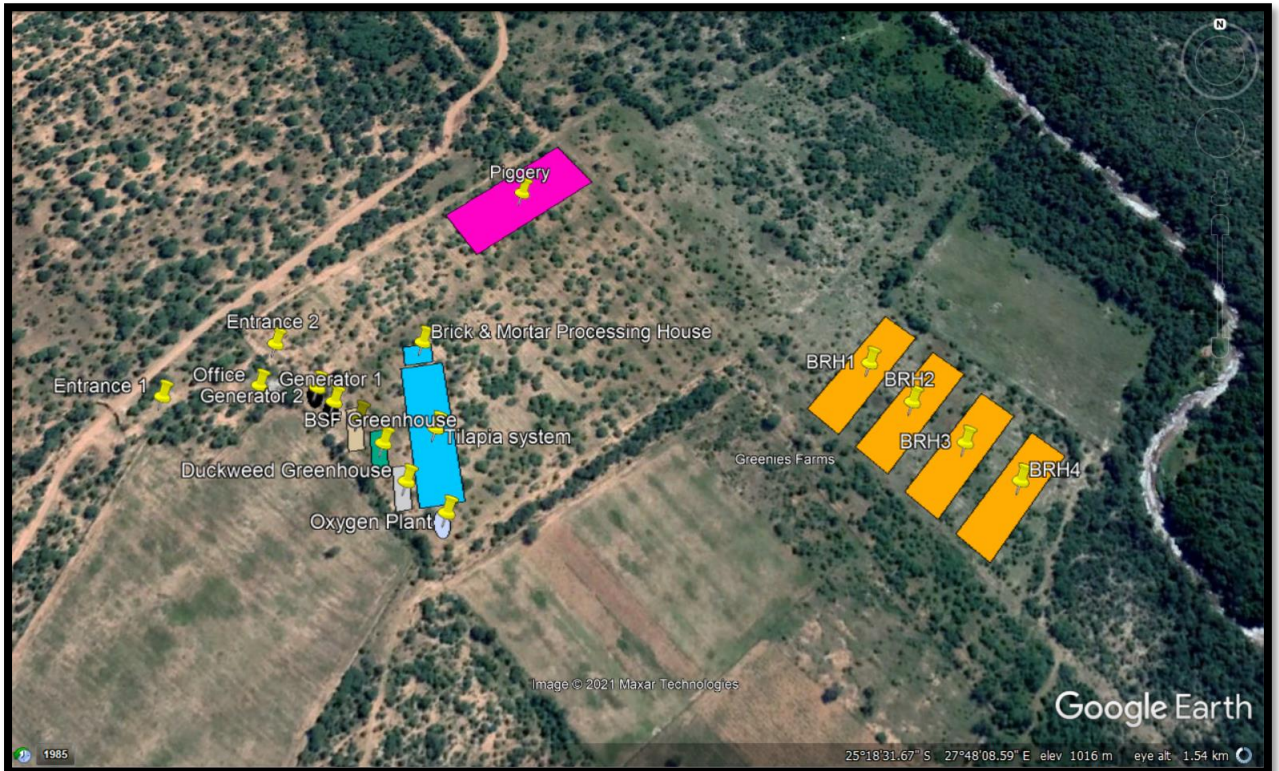


Figure 2: Google Earth image showing location (IDS).

The site is underlain by the Karoo Supergroup Formations.

F. Description of the Geological Setting

Description of the rock units:

Large areas of the southern African continent are covered by the Karoo Supergroup (Figure 3). It covers older geological formations with an almost horizontal blanket. Several basins are present with the main basin in the central part of south Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. An estimated age is 150 – 180 Ma. And a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent 1980, Snyman 1996). The Beaufort Group is underlain by the Ecca Group which lies on the Dwyka Group.

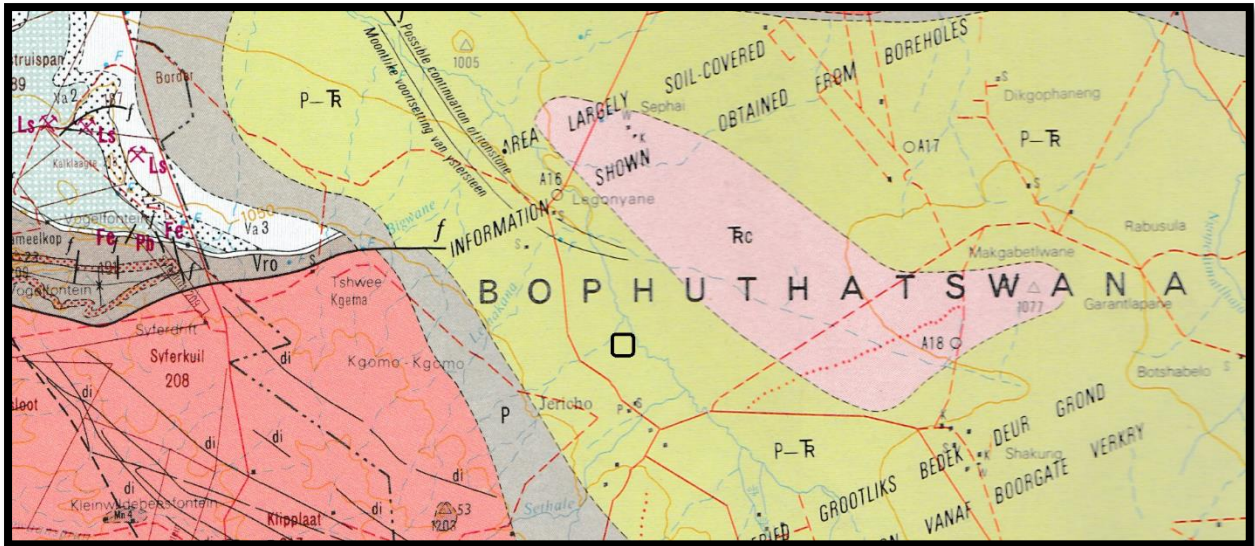


Figure 3: Geology of the development area (1h).

Legend to Figure and short explanation.

P-RT – Mudstone, siltstone, marl, sandstone and grit (green). Irrigasie Formasie, Karoo Supergroup. Permian.

P – Sandstone, shale, grit and conglomerate near base, coal seams (grey). Eccca Group, Karoo Supergroup. Permian.

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

--f-- Fault.

⊥5° - Strike and dip.

□ – Approximate position of farm (blocked in black).

Mining Activities on Figure:

Fe – Iron

Ls – Limestone and dolomite

Pb – Lead.

Mining past and present have no influence on the project.

The Irrigasie Formation of the Karoo Supergroup is Trias in age (± 209 million years). This basin is present in the Springbok Flats. The Irrigasie Formation is a succession of predominantly red mudstone lying between the Eccca Group and the Clarens Sandstone (Kent 1980). In this area, the Eccca Group forms the base. The red mudstone is interlayered with sandstone (Snyman 1996). The Irrigasie Formation is comparable to the Clarens Sandstone (± 209 million years). The largest Karoo Supergroup basin is the area known as the Karoo, but smaller basins are located in the Lebombo area, Springbok Flats and Ellisras, and north of the Soutpansberg towards Tshipise-Pafuri and further westward into Namibia (Kent 1980). The presence of a number of outliers of Eccca strata between Witbank and Pienaarsrivier indicates that the Springbok Flats basin and the main Karoo basin were probably originally linked (Kent 1980). In this area, the Eccca Group forms the base. The red mudstone is interlayered with sandstone (Snyman 1996). The dumps and old smoke stacks near Hammanskraal are from the fire-clay workings. These are from weathered shale of the Eccca Group of the Karoo Supergroup (Norman and Whitfield 2006). Between Hammanskraal and Bela Bela the Karoo Supergroup sediments is believed to dip gently northwards.

The Eccca Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Eccca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Eccca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Eccca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. It consists essentially of mudrock (shale), but sandstone-rich units occur

towards the margins of the present main Karoo basin in the south, west and north-east, with coal seams also being present in the north-east (Kent 1980, Johnson 2009).

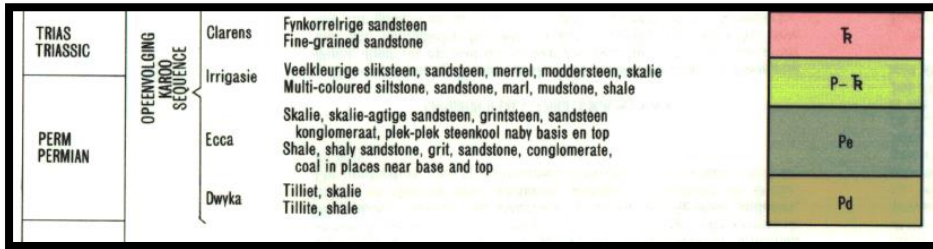


Figure 4: Lithostratigraphic column of the development area (Walraven 1981).

Field Observation: The walk through was done towards the middle of October 2021, conditions were hot and dry. Photographs below show the fairly flat topography. A variety of soil types (overburden and topsoil) will be present. This project covers quite a large area, but it is accessible. Short grass, alien invasive species, bushes, and trees are present. Clearing, overgrazing, and ploughing are taking place. A gravel road cuts through the property. The river is present on the eastern side. No outcrops or fossils were found (Figures 5-11).



Figure 5: General view of area towards the south.



Figure 6: Overall view of the area from the south-west corner showing middle of project area.

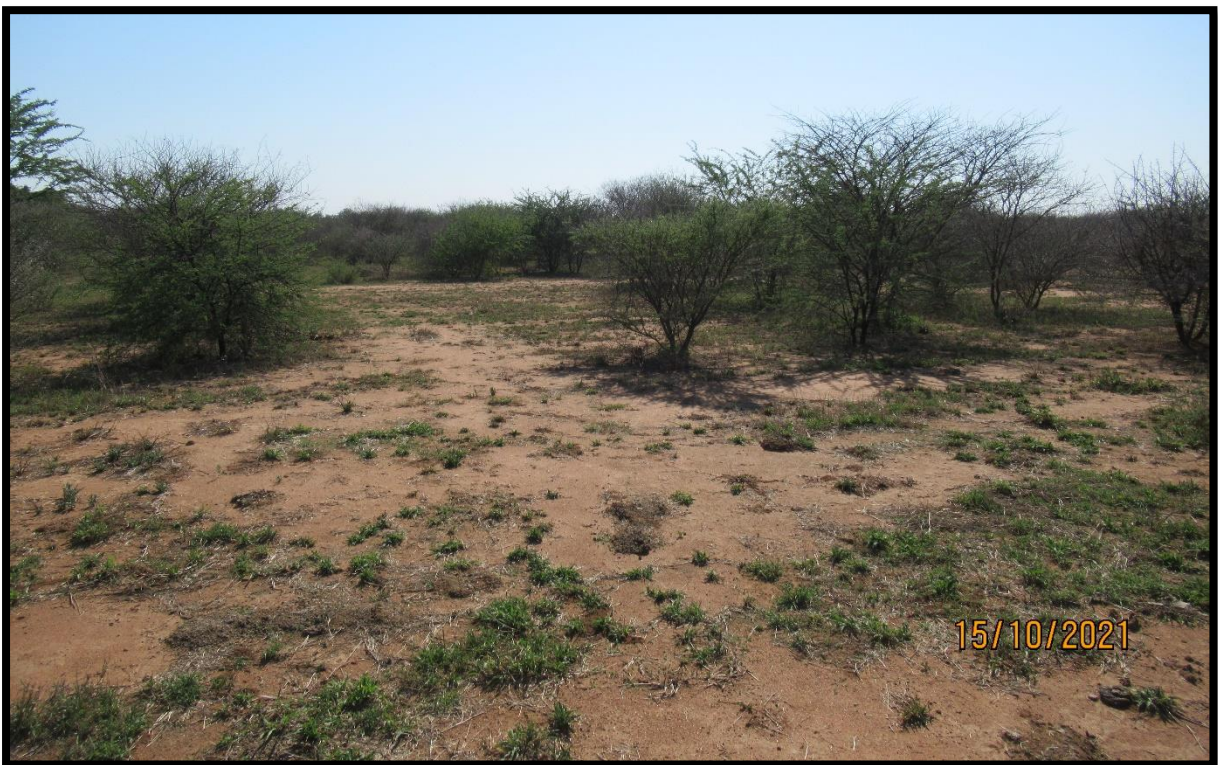


Figure 7: View towards the north from the north-west corner.



Figure 8: View towards the east.



Figure 9: Another view (west).



Figure 10: View close to river in the north-east.



Figure 11: Looking towards the river.

It is recommended to wait for the response from SAHRA on the Phase 1: Field Study (this report). SAHRA protocol must be followed.

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).

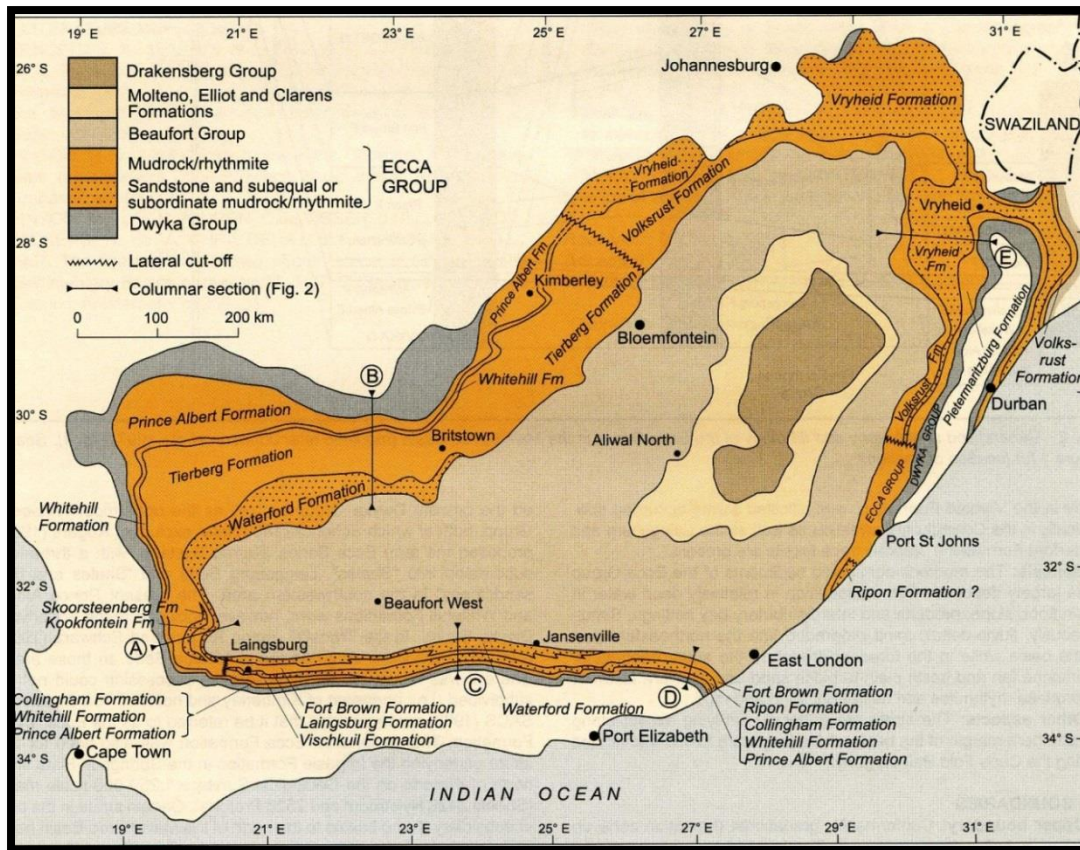


Figure 12: Extent of the Karoo Supergroup (Johnson 2009).

The development will be situated on the Irrigasi Formation of the Karoo Supergroup which is usually fossiliferous. Conifers are present often associated with ferns, cycads and cycadioides (Anderson 1999). It shows extensive bioturbation by trace fossils. Dinosaur fossils include the possible remains of 'Euskelosaurus' and *Gigantoscelsis* (Groenewald & Groenewald 2014).



Figure 13: Photograph of fossil horsetail fern stem, courtesy of Prof. Bamford, The Evolutionary Studies Institute (Photograph: H. Fourie).

There are several clay mines north of Pretoria, Hammanskraal and the Tswaing crater that used the white clay from the Eccca Group for brick making. These quarries are fossiliferous.

The Eccca Group, may contain fossils of diverse non-marine trace, *Glossopteris* flora, mesosaurid reptiles, palaeoniscid fish, marine invertebrates, insects, and crustaceans (Johnson 2009). *Glossopteris* trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the northern part of the Karoo Basin that the glossopterids and cordaitales, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge 2005).

The *Glossopteris* flora is thought to have been the major contributor to the coal beds of the Eccca. These are found in Karoo-age rocks across Africa, South America, Antarctica, Australia and India. This was one of the early clues to the theory of a former unified Gondwana landmass (Norman and Whitfield 2006).

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 1: Taken from Palaeotechnical Report (Groenewald 2012) (1cA).

Clarens (TR; TRc)		Aeolian sandstone	Dinosaur remains and trackways can be expected	Very poor levels of surface exposure (most data obtained from borehole cores)
Irrigasie (P-TRi; P-TR)		Multi-coloured mudstone, siltstone	Extensive bioturbation by trace fossils. Dinosaur remains include possible " <i>Euskelesaurus</i> " including so-called <i>Gigantoscetus</i> (indeterminate sauropod remains which may in fact come from Clarens Fm)	
Eccca (P; Pe)		Shale, sandstone with coal seams	Rich assemblages of plant fossils (<i>Glossopteris</i> Flora), including tree trunks, stumps and roots, palynomorphs, rare insects, conchostracans, low diversity trace fossil assemblages.	

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

Rock Unit	Significance/vulnerability	Recommended Action
Irrigasie Formation	Very High	Field assessment and protocol for finds is required
Eccca Group	High	Desktop Study is required and field assessment likely

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

Impact: **VERY HIGH** for the Irrigasie Formation, Karoo Supergroup. There are significant fossil resources that may be impacted by the development (mudstone, shale) and if destroyed are no longer available for scientific research or other public good (Almond, *et al.* 2009).

The Project includes one locality Option (see Figure 2) (1f,j) The palaeontological sensitivity is as stated above. Option 1: An area outlined with structures indicated in different colours and labelled. Brits is 32 km to the south-west and Jericho is 50 m to the south. A river is present on the east. The approximate size of the site is 4 hectares.

All the land involved in the development was assessed (**ni,nii**) and none of the property is unsuitable for development (see Recommendation B).

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in October 2021. A Phase 1: Field Survey of the affected portion includes photographs (in 7.1 mega pixels) taken of the site with a digital camera (Canon PowerShot A470). Additionally, Google Maps will be accessed on a cellular phone/ipad for navigation. A Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds and outcrops (bedrock) when the area is not covered with topsoil, subsoil, overburden, vegetation, grassland, trees or waste. The survey did identify the Karoo Supergroup. A literature survey is included and the study relied heavily on geological maps.

SAHRA document 7/6/9/2/1 (SAHRA 2012) requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate on outcrops which may be recorded with 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. Archaeozoologists concentrate on more recent fossils in the 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.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

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

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

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

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

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

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

(b) Grade 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

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

The development will be situated on the Irrigasie Formation of the Karoo Supergroup which is usually fossiliferous. Conifers are present often associated with ferns, cycads and cycadioides (Anderson 1999). It shows extensive bioturbation by trace fossils. Dinosaur fossils include the possible remains of 'Euskelosaurus' and *Gigantoscelis* (Groenewald & Groenewald 2014).

Fossils likely to be found are mostly plants (Appendix 1) such as '*Glossopteris flora*'. The aquatic reptile *Mesosaurus* and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. During storms a great variety of leaves, fructifications and twigs accumulated and because they were sandwiched between thin films of mud, they were preserved to bear record of the wealth and the density of the vegetation around the pools. They make it possible to reconstruct the plant life in these areas and wherever they are found, they constitute most valuable palaeobotanical records (Plumstead 1963) and can be used in palaeoenvironmental reconstructions (Appendix 1).

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

The threats are:-

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

J. Recommendation

- a. There is no objection (see Recommendation B) to the development, it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field Study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity of the area is **VERY HIGH**. A Phase 2 Palaeontological Mitigation is only required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation (Karoo Supergroup) and fossils or if fossils are found during mining. Protocol is attached (Appendix 2).
- b. This project may benefit the community, will create short- and long-term employment, the life expectancy of the community, revenue generation, skills transfer and training, the growth of the community and social development in general.
- c. Preferred choice: Locality Option 1 is preferred and possible.
- 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 **(1o,p,q)**.
- f. This report must be submitted to SAHRA together with the Heritage Impact Assessment Report.

Sampling and collecting:

Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

- a. Objections: Cautious. See heritage value and recommendation.
- b. Conditions of development: See Recommendation.
- c. Areas that may need a permit: Yes.
- d. Permits for mitigation: **Needed from SAHRA/PHRA prior to Mitigation.**

K. Conclusions

- a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
- b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field Study was provided by the Consultant. All technical information was provided by Information Decision Systems.
- 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 clearing, digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.
- 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 (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 Phase 1: Field Study may have missed palaeontological resources in the project area as outcrops are not always present or visible 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.

POPI Act 2013 Statement

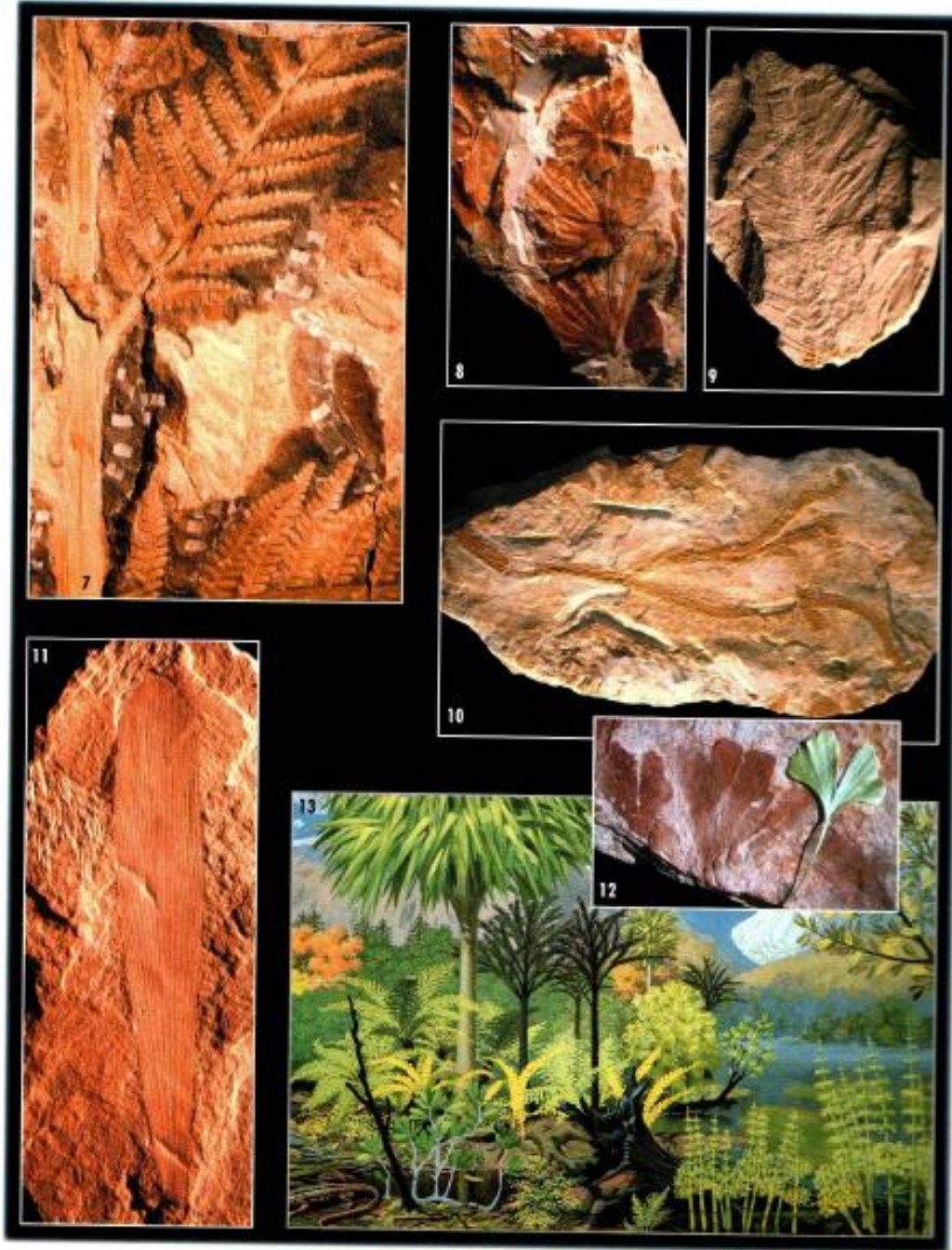
It provides that everyone has the right to privacy and includes a right to protection against the unlawful collection, retention dissemination and use of personal information contained in this document and pertains to the phone and contact details, signature and contents.

As per the Declaration Section none of the information may be shared without the permission of the author.

The document will be signed as soon as comments are received.

Heidi Fourie
2021/10/25

Appendix 1: Example of Ecca Group plant fossils (MacRae 1999)



Appendix 2: Protocol for Chance Finds and Management Plan (1k,l,m)

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).

- 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. Construction workers must be informed that this is a no-go area.
- It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-construction training of the ECO or during the digging and excavation phase of the development.
- The ECO must visit the site after clearing, drilling, excavations and blasting and keep a photographic record.
- The developer may be required to survey the areas affected by the development and indicate on plan where the construction / development / mining 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. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

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

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future

research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

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

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

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

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data. When the route is better defined, it is recommended that a specialist undertake a 'walk through' of the entire road as well as construction areas, including camps and access roads, prior to the start of any construction activities, this may be done in sections.
2. When clearing vegetation, topsoil, subsoil or overburden, hard rock (outcrop) is found, the contractor 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 every 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. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils are visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

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

The South African Heritage Resources Agency has the following documents in place:

Guidelines to Palaeontological Permitting policy.

Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.

Guidelines for Field Reports.

Palaeotechnical Reports (Eastern Cape, North West, Northern Cape, Mpumalanga, Gauteng, Western Cape, Free State, Kwazulu Natal, and Limpopo)

Appendix 3:

Table 2: Listing points in Appendix 6 of the Act and position in Report (bold in text).

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
F, B	1(ni)(iA)	Authorisation
F, 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
G, D	1(f)	Details or activities of assessment
G	1(j)	Description of findings
H	1(e)	Description of methodology
H	1(i)	Assumptions
J	1(o)	Consultation
J	1(p)	Copies of comments during consultation
J	1(q)	Information requested by authority
Declaration	1(b)	Independent declaration
Appendix 2	1(k)	Mitigation included in EMPr
Appendix 2	1(l)	Conditions included in EMPr
Appendix 2	1(m)	Monitoring included in EMPr
D	2	Protocol or minimum standard

Appendix 4: Impact Statement

The development footprint is situated on the **Irrigasie Formation** (P-RT) of the Ecca Group, Karoo Supergroup with a **Very High** palaeontological sensitivity. The nature of the impact is the destruction of Fossil Heritage. Loss of fossil heritage will have a negative impact. The extent of the impact only extends in the region of the development activity footprint and may include transport routes. The expected duration of the impact is assessed as potentially permanent. The intensity/magnitude of the impact is high as it is destructive. The probability of the impact occurring will be definite and will occur regardless of preventative measures.

In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be irreversible. With Mitigation the impact will be moderate and the cumulative impact is low. Impacts on palaeontological heritage during the construction and preconstruction phase could potentially occur and is regarded as having a high possibility. The significance of the impact occurring will be as below:

S= (2+5+8)5

75 High (>60).