

Opencast Mine Extension of Pit 1 and Water Transportation Pipeline from the Exxaro Dorstfontein West to
Dorstfontein East Mine

Nkangala District Municipality, eMalahleni Local Municipality, Mpumalanga Province

Farm: Dorstfontein 71-IS and Welstand 55-IS

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 993 3110

Palaeontological Impact Assessment: Phase 1 Field Study

Commissioned by: SRK Consulting

P.O. Box 35290,

Menlo Park, Pretoria

0102

012 361 9821

Ref: Pending

2017/08/13



B. Executive summary

Outline of the development project: SRK Consulting has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field study of the suitability of the Opencast Mine Extension of Pit 1 and Water Transportation Pipeline from the Exxaro Dorstfontein West to Dorstfontein East Mine and associated infrastructure near Kriela on Dorstfontein 71-IS and Welstand 55-IS in the Nkangala District Municipality, eMalahleni Local Municipality within the Mpumalanga Province.

The project applicant, Dorstfontein Coal Mines (Pty) Ltd intends to expand the opencast mining of Pit 1 at their Dorstfontein East Mine to ensure a constant Run of Mine of 3 mega tonnes per annum, and then construct a pipeline of approximately 11 km for the transportation of process water which will be recycled.

The Project includes three Alternatives for the mine (Figure 1):

Alternative 1: This is the expansion of the opencast mine referred to as Pit 1 extension, it covers the reserves. Additionally a water pipeline will be constructed.

Alternative 2: Mining of Pit 1 extension by means of opencast methods on the north-eastern side and the north-western side by means of underground mining using continuous mining procedures.

No-go Option: No mining and jobs will be lost.

The project also includes three Alternatives for the Pipeline (Figure 1):

Alternative 1: Makes use of existing farm and mine roads and crosses the R544. Preferred.

Alternative 2: Makes use of the mine area and partly through agricultural land. Preferred by this study.

Alternative 3: Travels around the mine and partly through agricultural land.

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).

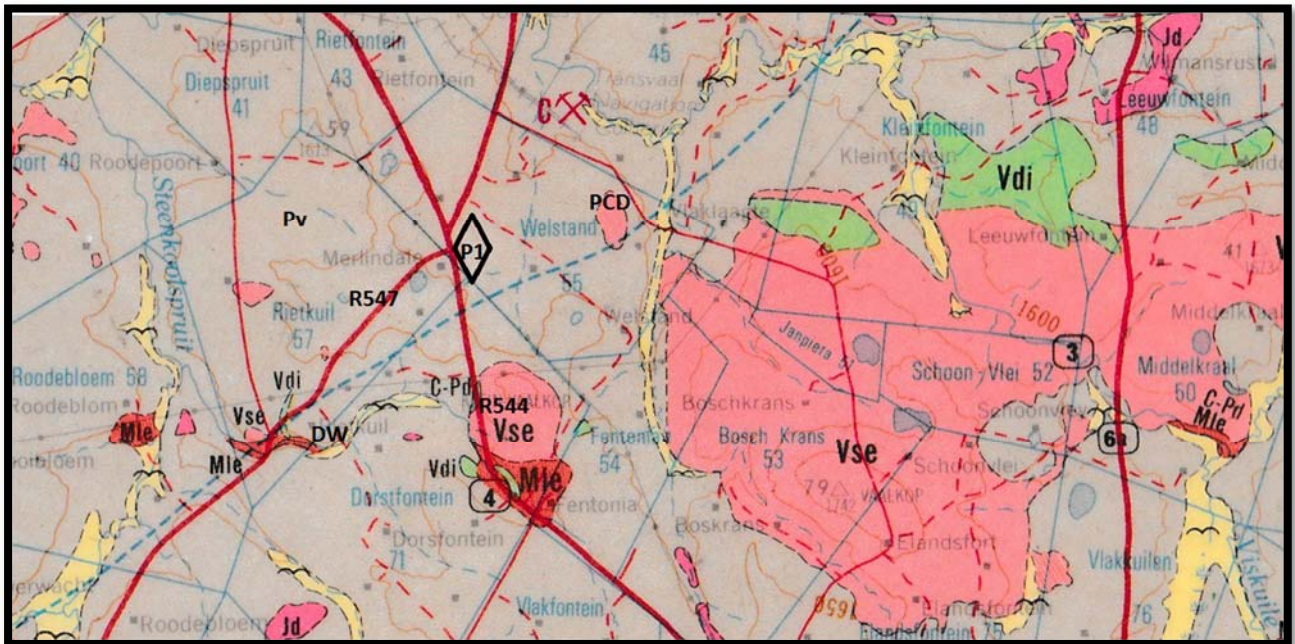
Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge 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 2528 East Rand Geological Map (Keyser, Botha and Groenewald 1986).

Figure 4: The geology of the development area.



Legend to map and short explanation.

m – Alluvium (yellow). Quaternary.

Pv – Sandstone, shale, coal beds (brown). Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.

C-Pd – Diamictite, shale (khaki). Dwyka Group, Karoo Supergroup. Carboniferous.

Mle – Medium-grained porphyritic granite, red, coarse-grained biotite granite. Lebowa Granite Suite, Bushveld Complex. Mokolian.

Vdi – Diabase (green). Vaalian.

Vse – Porphyritic rhyolite with interbedded mudstone and sandstone (amber). Selons River Formation, Rooiberg Group, Transvaal Supergroup. Vaalian.

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

----- - Concealed geological boundary.

[3] – Site of geological interest.

□ – Approximate position of Pit 1 Extension, PCD – Pollution Control Dam, DW – Dorstfontein West Mine.

Mining Activities:

C - Coal.

Summary of findings (1d): The Phase 1 PIA Field study was undertaken towards the end of July in the winter in mild conditions and the following is reported:

The new Pit 1 Extension will be situated on the Vryheid Formation. A section of the new pipe line will be situated on agricultural land which is covered with grass and outcrops are scarce, the remaining section will run through or past the mining activities.

The Karoo Supergroup is renowned for its fossil wealth. The Vryheid Formation (Pe, Pv), Eccu Group is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications (Appendix 1). This formation is early to mid-Permian (Palaeozoic) in age and consists of sandstone, shaly sandstone, grit, conglomerate, coal and shale. Coal seams are present in the Vryheid Formation within the sandstone and shale layers. Fossils are mainly present in the grey shale which is interlayered between the coal seams (Kent 1980, Visser 1989). Borehole logs in the coalfields show the following layers; soil, shale and sandstone, shale and sandstone interbedded, sandstone, coal, conglomerate reworked diamictite, Dwyka Tillite, and the Pre-Karoo Basement.

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 VERY HIGH for the Vryheid Formation (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:

The potential impact of the development on fossil heritage is VERY HIGH and therefore a field survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol). A Phase 2 PIA and or mitigation are only recommended if the Phase 1: Field study finds fossils (plants). The drive through and walk through did not find any fossils, but may have missed outcrops due to mining operations.

The survey was done in winter towards the end of July, conditions were mild and dry and the area is covered by overburden, vegetation, natural grassland and other land uses include roads. Recent structures from the mining operations are present. The site is located on a sloping topography. The area is undermined and very disturbed by opencast mining. The Exxaro Dorstfontein West Mine is located on the Quaternary Formation that can be seen on the geological map. The pipe line will cross the Selons River Formation which does not contain fossils. The pipe line will be constructed using small square footings on the surface (Route 3), therefore not intruding into any geological formation.

The Project includes three Alternatives for the mine (Figure 1):

Alternative 1: This is the expansion of the opencast mine referred to as Pit 1 extension, it covers the reserves. Additionally a water pipeline will be constructed.

Alternative 2: Mining of Pit 1 extension by means of opencast methods on the north-eastern side and the north-western side by means of underground mining using continues mining procedures.

No-go Option: No mining and jobs will be lost.

The project also includes three Alternatives for the Pipeline (Figure 1):

Alternative 1: Makes use of existing farm and mine roads and crosses the R544. Preferred by the mine.

Alternative 2: Makes use of the mine area and partly through agricultural land. Preferred by this study.

Alternative 3: Travels around the mine and partly through agricultural land.

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

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

The recommendations are:

1. Mitigation may be needed (Appendix 2) if fossils are found.
2. No consultation with parties was necessary. The development may go ahead with caution, but the ECO must survey for fossils during ground breaking and construction of the pipe line in line with the legally binding Environmental Management Programme (EMPr) this must be updated to include the involvement of a palaeontologist.
3. The mine Stock Pile must be made available for palaeontological studies when requested.

Stakeholders: Developer – Dorstfontein Coal Mines (Pty) Ltd, Private Bag X5007, Ganala,12271, tel. 011 441 6857.

Environmental – SRK Consulting. P.O. Box 35290, Menlo Park, Pretoria, 0102, tel. 012 361 9821.

Landowner – Dorstfontein Coal Mines (Pty) Ltd, Private Bag X5007, Ganala,12271, tel. 011 441 6857.

C. Table of Contents

A. Title page	1
B. Executive Summary	2
C. Table of Contents	4
D. Background Information on the project	6
E. Description of the Property or Affected Environment	7
F. Description of the Geological Setting	8
G. Background to Palaeontology of the area	13
H. Description of the Methodology	14
I. Description of significant fossil occurrences	16
J. Recommendation	17
K. Conclusions	17
L. Bibliography	18
Declaration	19

Appendix 1: Examples of Vryheid Formation fossils	20
Appendix 2: Protocol for finds and Management Plan	21
Appendix 3: Table	22

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 3).

Outline of development

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

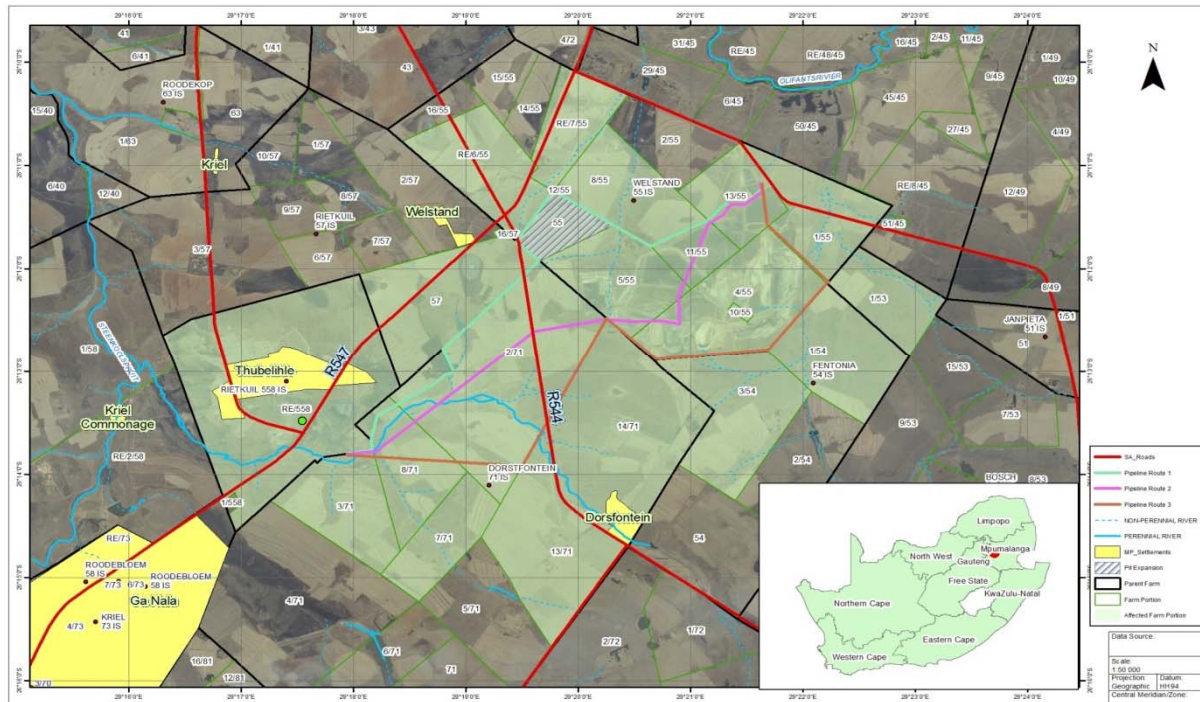
The project applicant, Dorstfontein Coal Mines (Pty) Ltd (Exxaro) plans to expand the opencast mining of Pit 1 in a north-western direction of approximately 85 hectares, ensuring a constant Run of Mine (RoM) of 3 mtpa (mega tonnes per annum). In addition to this, Exxaro would like to relay a pipeline from Dorstfontein West Mine of approximately 11 km for the transportation of process water, which will be recycled.

An extension of the current mine will generate economic returns for stakeholders such as employees, their dependants, shareholders, the community, local, provincial and national government. It will create more employment amongst the local community.

Related infrastructure:

1. New Pit Extension,
2. Pipe line,
3. Existing mine infrastructure.

Figure 1: Aerial view of Proposed Development (SRK Consulting).



Rezoning/ and or subdivision of land: No.

Name of developer and consultant: Dorsfontein Coal Mines (Pty) Ltd and SRK Consulting.

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.

Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past ten years she carried out field work in the Eastern Cape, Free State, Gauteng, Limpopo and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 23 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.

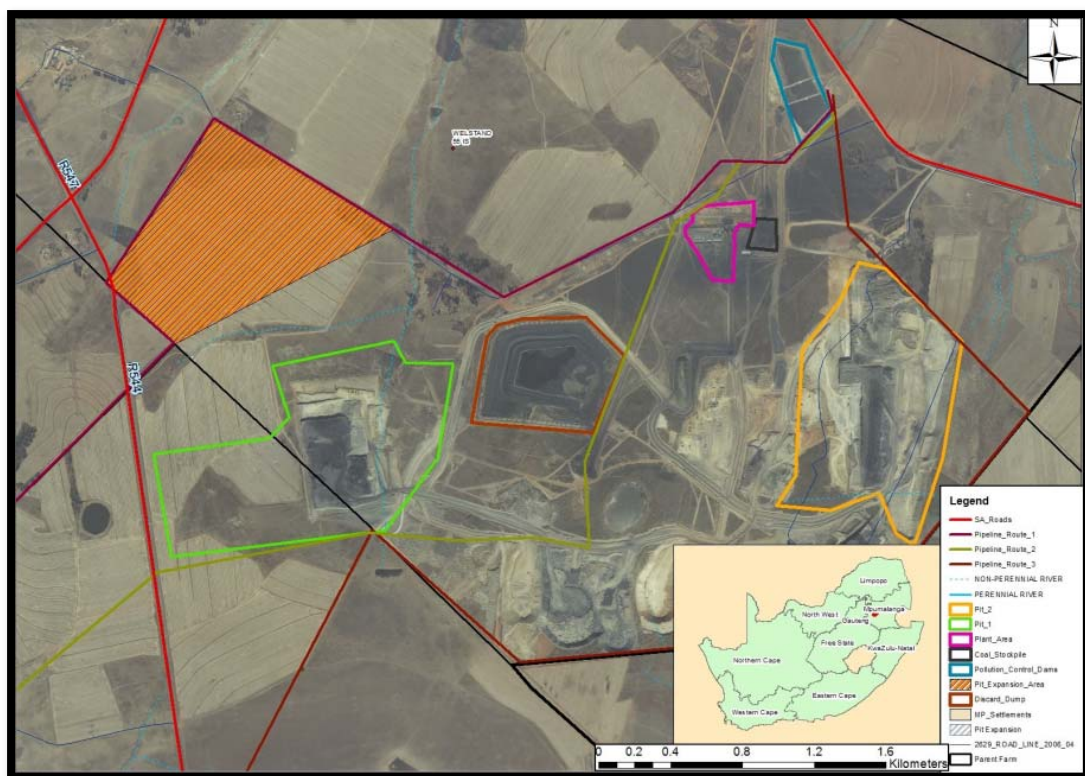
E. Description of property or affected environment

Location and depth:

The Opencast Mine Extension of Pit 1 and Water Transportation Pipeline from the Exxaro Dorsfontein West to Dorsfontein East Mine and associated infrastructure will be situated on Dorsfontein 71-IS and Welstand 55-IS in the Nkangala District Municipality, eMalahleni Local Municipality within the Mpumalanga Province.

Depth is determined by the infrastructure to be developed and the thickness of the formation in the development area, in this instance, the mining activities. The pipe line will be constructed above ground using small square blocks as foundations.

Figure 3: Google.earth Image showing Mine Infrastructure (SRK Consulting).



The site is mostly underlain by the sediments of the Vryheid Formation. It does not intrude into the Dwyka Formation and the Quaternary outcrop has already been destroyed by the Exxaro Dorstfontein West Mine operations. The Selons River Formation may be crossed with the pipe line (Route 3).

F. Description of the Geological Setting

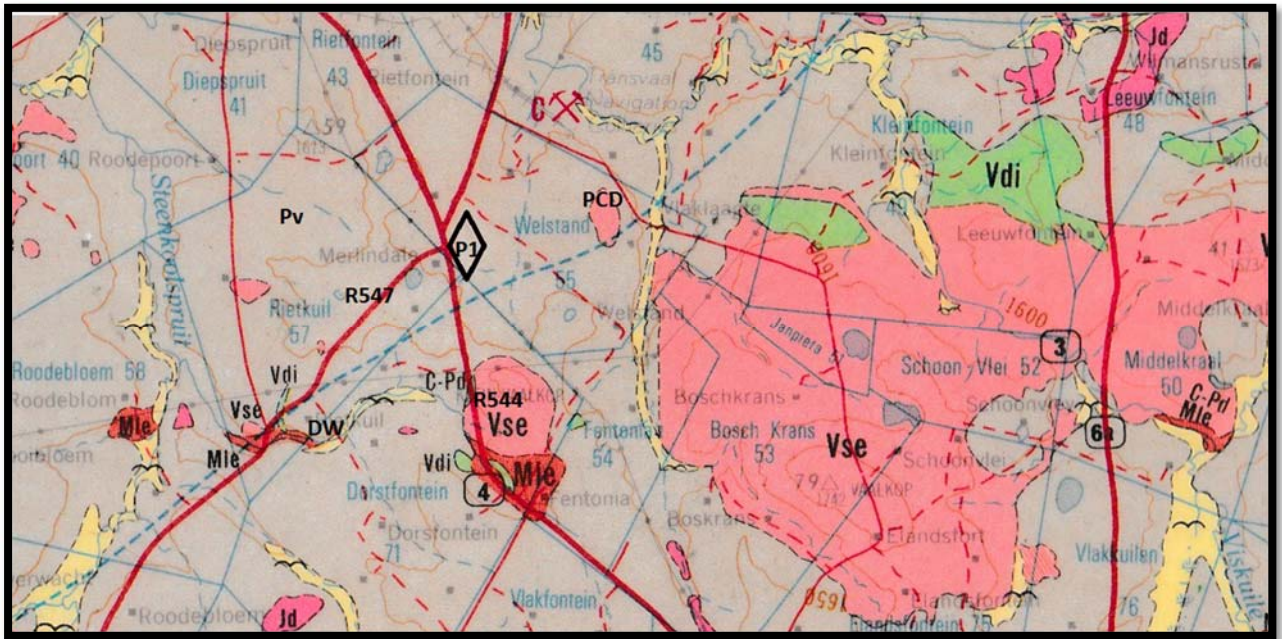
Description of the rock units:

The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. 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. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts (Kent 1980, Snyman 1996). The Beaufort Group is underlain by the Eccra Group which is underlain by the Dwyka Group.

The southern part of the Karoo basin is 3000 m thick, but the northern part of the basin is much thinner. The animals present during Beaufort times flourished on the floodplains, lakes and marshes. Sandstone is deposited in times of flooding in the river channels and the mudstones were deposited on the floodplains in the shallow lakes (Snyman 1996).

Large areas of the southern African continent are covered by the Karoo Supergroup. The Eccra Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Eccra group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Eccra 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 Eccra 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: Excerpt of 1:250 000 Geological Map 2528 Pretoria (Walraven 1978).



Legend to map and short explanation.

m – Alluvium (yellow). Quaternary.

Pv – Sandstone, shale, coal beds (brown). Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.

C-Pd – Diamictite, shale (khaki). Dwyka Group, Karoo Supergroup. Carboniferous.

Mle – Medium-grained porphyritic granite, red, coarse-grained biotite granite. Lebowa Granite Suite, Bushveld Complex. Mokolian.

Vdi – Diabase (green). Vaalian.

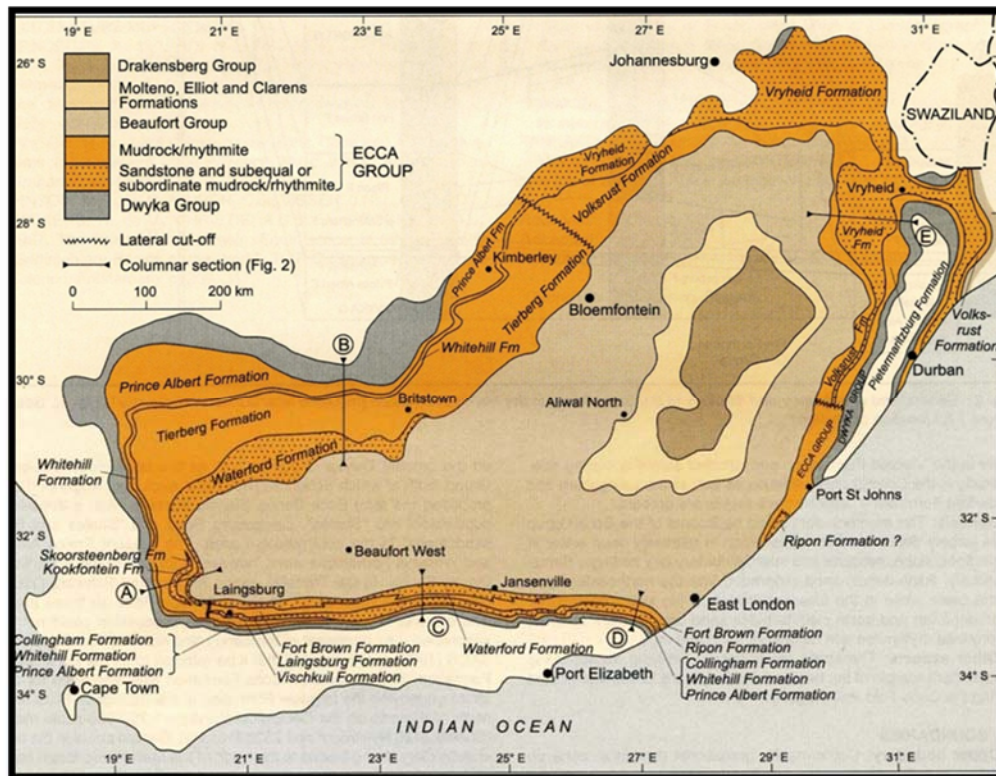
Vse – Porphyritic rhyolite with interbedded mudstone and sandstone (amber). Selons River Formation, Rooiberg Group, Transvaal Supergroup. Vaalian.

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

----- - Concealed geological boundary.

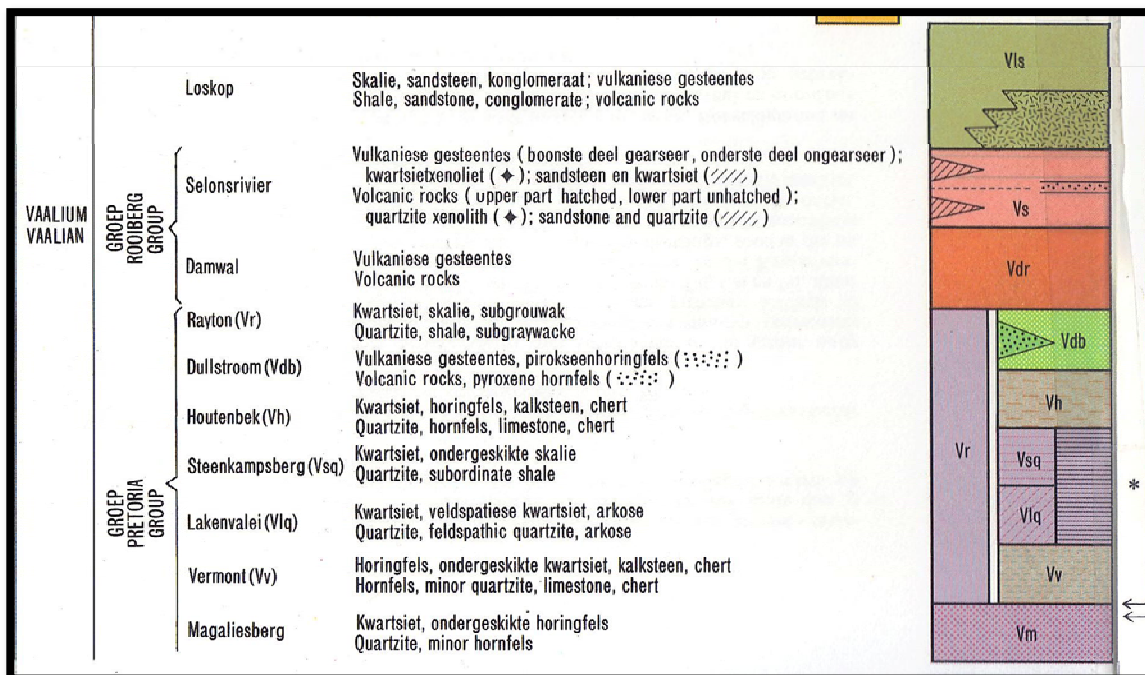
□ – Approximate position of Pit 1 Extension, PCD – Pollution Control Dam, DW – Dorstfontein West Mine.

Figure 5: Geology of the Karoo Supergroup (Johnson 2009).



The Vryheid Formation is named after the type area of Vryheid-Volksrust. In the north-eastern part of the basin the Vryheid Formation thins and eventually wedges out towards the south, southwest and west with increasing distance from its source area to the east and northeast (Johnson 2009). The Vryheid Formation consists essentially of sandstone, shale, and subordinate coal beds, and has a maximum total thickness of 500 m. It forms part of the Middle Ecca (Kent 1980). This formation has the largest coal reserves in South Africa. The pro-delta sediments are characterised by trace and plants fossils (Snyman 1996).

Figure 5: Lithostratigraphic column of part of the Transvaal Supergroup (Walraven 1978).



Coal has always been the main energy source in industrial South Africa. It is in Mpumalanga, south of the N4, that most of the coal-fired power stations are found. Eskom is by far the biggest electricity generator in Africa. Thick layers of coal just below the surface are suited to open-cast mining and where the overlying sediments are too thick, shallow underground mining. In 2003, coal was South Africa's third most valuable mineral commodity and is also used by Sasol for fuel- and chemicals-from-coal (Norman and Whitfield 2006). Grodner and Cairncross (2003) proposed a 3-D model of the Witbank Coalfield to allow easy evaluation of the sedimentary rocks, both through space and time. Through this, one can interpret the environmental conditions present at the time of deposition of the sediments. This can improve mine planning and mining techniques. The Vryheid Formation is underlain by the Dwyka Group and is gradually overlain by mudstones (and shale) and sandstones of the Volksrust Formation. The typical colours for the Vryheid Formation are grey and yellow for the sediments and black for the coal seam. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). The site itself is partly situated on the flat-lying Vryheid Formation, Ecca Group, Karoo Supergroup. Dolerite dykes do occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

The Vryheid Formation sediments may attain a thickness of 120 – 140 m. A typical profile includes soil and clay, sandstone and siltstone, shale, 2 upper seam, shale, 2 seam, sandstone, no 1 seam, shale and dolomite at the bottom. Diabase or dolerite dykes are also present in the area.

The typical colours for the Vryheid Formation are grey and yellow for the sediments and black for the coal seam. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

The walk through was done towards the end of July 2017, conditions were mild and dry. Photographs below show the sloping topography. A variety of soil types (overburden and topsoil) will be present. The walk through did not locate fossils.

Field Observations

Figure 6: The site is currently underutilised. It was used for maize crops. This will be the Pit Extension



Figure 7: View towards the mine works and Route 1 of the pipe line.



Figure 8: Area where pipe line Route 3 will run, it will come from behind the dumps towards the



The Project includes three Alternatives for the mine (Figure 1):

Alternative 1: This is the expansion of the opencast mine referred to as Pit 1 extension, it covers the reserves. Additionally a water pipeline will be constructed.

Alternative 2: Mining of Pit 1 extension by means of opencast methods on the north-eastern side and the north-western side by means of underground mining using continues mining procedures.

No-go Option: No mining and jobs will be lost.

The Pit 1 Extension will be situated on the Vryheid Formation.

The project also includes three Alternatives for the Pipeline (Figure 1):

Alternative 1: Route 1: Makes use of existing farm and mine roads and crosses the R544. Starts at Dorstfontein West Mine and continues over the R 544 around the new pit extension in a north-easterly direction to end at the Pollution Control Dam. Completely situated on the Vryheid Formation.

Alternative 2: Makes use of the mine area and partly through agricultural land. Starts at the Dorstfontein West mine and travels south of the existing mine round the Discard Dump and to the north of the Plant Area and the Coal Stockpile towards the Pollution Control Dam. Will be situated mostly on existing mine operations and the Vryheid Formation. From a palaeontological point of view this is the best option and the shortest.

Alternative 3: Travels around the mine and partly through agricultural land. Starts at the Dorstfontein West mine then continues south of the mine operations, around pit 2 on the outside and then north towards the Pollution Control Dam. This option transects the Vryheid Formation and the Selons River Formation.

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 Ecca 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 Ecca. 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).

Subgroup / Supergroup	Group	Formation	Fossil Heritage	Comment
Karoo Supergroup	Ecca	Vryheid	Rich fossil plant assemblages of the Permian Glossopteris flora, rare fossil wood, diverse palynomorphs. Abundant low diversity trace fossils, rare insects, possible conchostracans, non-marine bivalves, fish scales	Globally important and under collected
Transvaal Supergroup	Rooiberg	Selons River	No fossils recorded	-

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

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

Rock Unit	Significance/vulnerability	Recommended Action
Vryheid Formation (Pv) (Pe)	Very High	Field assessment and protocol for finds is 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: VERY HIGH for the Vryheid Formation. There are significant fossil resources that may be impacted by the development (shale).

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken towards the end of July 2017. The walk through of the affected portion was done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (PowerShot SX620HS). It was not necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops where not covered with topsoil, subsoil, overburden, and vegetation. The walk through did identify the Malmani Subgroup. A literature survey is included.

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. 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 11: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and

(c) Grade 111: Other heritage resources worthy of conservation.

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

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

Local authorities identify and manage Grade 111 heritage resources.

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

Archaeology, palaeontology and meteorites: Section 35.

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

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

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction

phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

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

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

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

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

I. Description of significant fossil occurrences (1f)

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially VERY HIGH for the Vryheid Formation, Ecca Group. Rocks of Permian age in South Africa are particularly rich in fossil plants (Rayner and Coventry 1985). The fossils are present in the grey shale interlayered with the coal seams. The fossils are not very rare and also occur in other parts of the Karoo stratigraphy. The pollen of the Greenside Colliery also on the Vryheid formation was the focus of a Ph.D study. It is often difficult to spot the greyish fossils as they are the same colour as the grey shale in which they are present as these coalified compressions have been weathered to leave surface replicas on the enclosing shale matrix. A locality close to Ermelo, also Vryheid Formation, has yielded *Scutum*, *Glossopteris* leaves, *Neoggerathiopsis* leaves, the lycopod *Cyclodendron leslii*, and various seeds and scale leaves (Prevec 2011).

Fossils likely to be found are mostly plants (Appendix 1) such as '*Glossopteris flora*' of the Vryheid Formation. The aquatic reptile *Mesosaurus* and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve *Megadesmus* is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

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.

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 vast coal mining industry (Vryheid Formation) provides palaeontologists with fantastic access to coal-associated plant fossils, while simultaneously resulting in the destruction of important National palaeontological heritage.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, mining activities, 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 to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is VERY HIGH. A Phase 2 Palaeontological Mitigation is only required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils. Fossils were not found during the walk through. The Protocol for Finds and Management Plan is attached (Appendix 2) for the ECO, the development may go ahead.
- b. This project will benefit the environment, economy, residents, and social development of the community.
- c. Preferred choice: Option 1. The impact on the palaeontological heritage is VERY HIGH. The presence of shale is problematic. Care must be taken during the digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary).
- d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.

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: Yes for the shale layer if a fossil is unearthed.
- d. Permits for mitigation: Needed from SAHRA/PHRA.

K. Conclusions

- a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
- b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was provided by SRK Consulting.
- c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
- d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures, especially 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 and adjacent areas as well as for safety and security reasons.

L. Bibliography

- ALMOND, J., PETHER, J. and GROENEWALD, G. 2013. South African National Fossil Sensitivity Map. SAHRA and Council for Geosciences.
- CADDICK, A. 2017. Scoping Report for the Opencast Mine Extension Pit 1 and Water Transportation Pipeline from Dorstfontein West to Dorstfontein East, eMalahleni Local Municipality, Mpumalanga Province.
- DE ZANCHE, V. and MIETTO, P. 1977. *The World of Fossils*. Sampson Low Guides, Berkshire, Printed in Italy, Pp 256.
- ERIKSSON, P.G. 1999. Pretoria Group, [Transvaal Supergroup]. Catalogue of South African Lithostratigraphic units (Edited Johnson, M.R.), South African Committee for Stratigraphy, Council for Geoscience, 6: 29-32.
- GRODNER, M. and CAIRNCROSS, B. 2003. A regional scale 3-D model of the Witbank Coalfield, Northern Karoo Basin, South Africa. *South African Journal of Geology*, 106(4): 249-264.
- GROENEWALD, G and GROENEWALD, D. 2014. SAHRA Palaeotechnical Report. Palaeontological Heritage of the Mpumalanga Province, Pp 23.
- JOHNSON, M.R. 2009. Eccu Group. Karoo Supergroup. Catalogue of South African Lithostratigraphic Units. SACS, 10: 5-7.
- KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy*. Handbook 8, Part 1, pp 690.
- KEYSER, N, BOTHA, G.A. and GROENEWALD, G.H. 1986. Geological Map of the East Rand, 2628, 1:250 000 South African Committee for Stratigraphy. Council for Geoscience, Pretoria.
- MCCARTHY, T and RUBIDGE, B. 2005. *The Story of Earth Life: A southern African perspective on a 4.6-billion-year journey*. Struik. Pp 333.
- NIXON, N., ERIKSSON, P.G., JACOBS, R. and SNYMAN, C.P. 1988. Early Proterozoic micro-algal structures in carbonaceous shales of the Pretoria Group, south-west of Potchefstroom. *South African Journal of Science*, 84: 592-595.
- NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys*. De Beers, Struik, P 1-320.
- PLUMSTEAD, E.P. 1963. The influence of plants and environment on the developing animal life of Karoo times. *South African Journal of Science*, 59(5): 147-152.
- PREVEC, R. 2011. A structural re-interpretation and revision of the type material of the glossopterid ovuliferous fructification *Scutum* from South Africa. *Palaeontologia africana*, 46: 1-19.
- RAYNER, R.J. and COVENTRY, M.K. 1985. A *Glossopteris* flora from the Permian of South Africa. *South African Journal of Science*, 81: 21-32.
- RUBIDGE, B. S. (ed.), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1, 46pp. Council for Geoscience, Pretoria.
- SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.
- SNYMAN, C. P., 1996. *Geologie vir Suid-Afrika*. Departement Geologie, Universiteit van Pretoria, Pretoria, Volume 1, Pp. 513.
- VAN DER WALT, M., DAY, M., RUBIDGE, B. S., COOPER, A. K. & NETTERBERG, I., 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. *Palaeontologia Africana*, 45: 1-5.
- VISSER, D.J.L. 1984 (ed). Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

VISSER, D.J.L. 1989 (ed). *Toeligting: Geologiese kaart (1:100 000). Die Geologie van die Republieke van Suid Afrika, Transkei, Bophuthatswana, Venda, Ciskei en die Koningkryke van Lesotho en Swaziland*. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

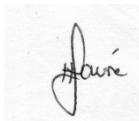
Declaration (disclaimer) 1(b)

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 Phase 1 PIA study may have missed palaeontological resources in the project area as outcrops are not always present or visible due to vegetation while others may lie below the overburden of earth and may only be present once development commences.

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



Heidi Fourie
2017/08/13

Appendix 1:

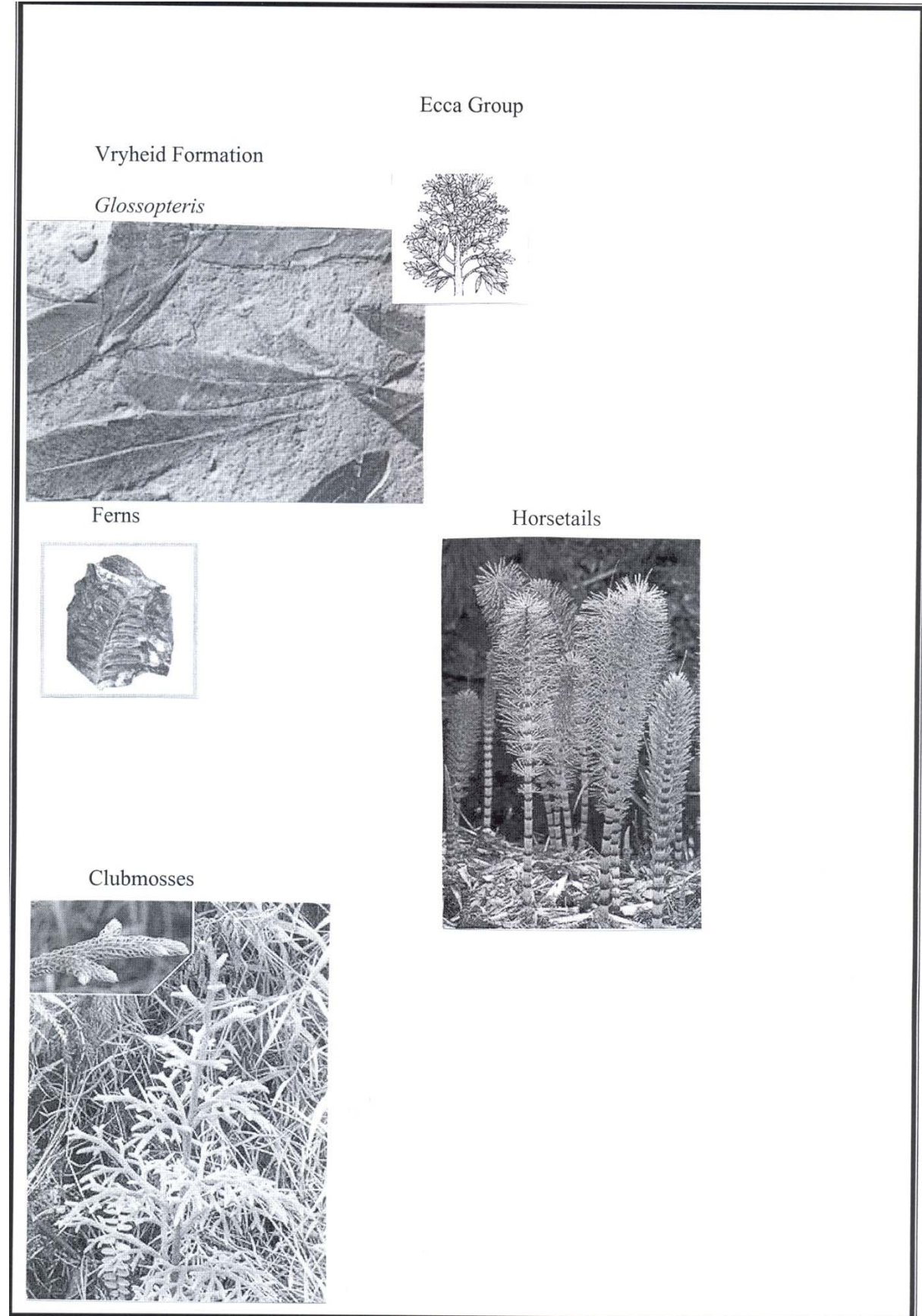


Figure 9: Examples of Vryheid Formation fossils.



Figure 10: Example of a plant fossil (courtesy of the ESI). *Glossopteris* leave.

Appendix 2: Protocol for 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 activities in line with the legally binding Environmental Management Programme (EMPr) so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. When a fossil is found the area must be fenced-off and the construction workers must be informed that this is a no-go area. Therefore the EMPr must be updated to include the involvement of a palaeontologist during the digging and excavation (ground breaking) phase of the development. This ECO should familiarise him- or herself with the Ecca Group formations and its fossils. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Ecca Group Fossils.

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

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. 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.

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.
2. Fossils likely to occur are 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 invertebrates from the Volksrust Formation (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 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 3: Table of Appendix 6 requirements.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"
	1(p)	"
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)	"
	1(m)	Sampling and collecting
	1(k)	"
Declaration	1(b)	Declaration
Appendix 2	1(k)	Protocol for finds
	1(m)	"
	1(q)	"

Table 4: Listing points in Appendix 6 of the Act and position in Report.