PALAEONTOLOGICAL ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF THE NEW GENERAL WASTE DISPOSAL SITE AT ESKOM MAJUBA POWER STATION, DR PIXLEY KA SEME LOCAL MUNICIPALITY, GERT SIBANDE DISTRICT MUNICIPALITY, MPUMALANGA PROVINCE.

Savannah Ref No.: SE3357

Prepared for:

Savannah Environmental (Pty) Ltd

PO Box 148

Sunninghill

Johannesburg

2157

April 2022

Prepared by

BANZAI ENVIRONMENTAL (PTY) LTD

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations, and all other applicable legislation.
- I will consider, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application.
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct.
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal, or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

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PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

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Email: elizebutler002@gmail.com

SIGNATURE: 

This Palaeontological Impact Assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1:NEMA Table

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**	**Comment where not applicable.**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vitae	Section 2 – refer to **Appendix A**	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Desktop Assessment	
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology	-
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Section 1 and 10	
(g) An identification of any areas to be avoided, including buffers	Section 5	No buffers or areas of sensitivity identified

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in report**	**Comment where not applicable.**
(h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1 – Assumptions and Limitation	-
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 1 and 11	
(k) Any mitigation measures for inclusion in the EMPr	Section 1 and 10	
(l) Any conditions for inclusion in the environmental authorisation	N/A	None required
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 11	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 11	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 1 and 11	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process will be conducted as part of the EIA and EMPr process.
(p) A summary and copies if any comments that were received during any consultation process	N/A	
(q) Any other information requested by the competent authority.	N/A	Not applicable.

Requirements of Appendix 6 – GN R326 EIA **Regulations of 7 April 2017**	**Relevant section in report**	**Comment where not applicable.**
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	

EXECUTIVE SUMMARY

Eskom Majuba Power Station has appointed Savannah Environmental (Pty) Ltd to undertake Studies for the EIA Phase of the Proposed Eskom Majuba Waste Disposal Site and associated infrastructure on a site approximately 13km southwest of Amersfoort and 40km north-northwest of Volksrust, within jurisdiction of the Dr Pixley Ka Isaka Seme Local Municipality, which forms part of the Gert Sibande District Municipality in the Mpumalanga Province. Two (2) alternative sites are being considered for establishment of the general waste disposal site, namely Alternative A, located on Portion 6 of the Farm Witkoppies 81HS and Alternative B, located on Portions 1 and 2 of the Farm Witkoppies 81HS. Both sites are contained within Eskom-owned land.

To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PDA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed layout alternatives are primarily underlain by Jurassic dolerite while surrounding areas are underlain by potentially fossiliferous sedimentary rocks of the Early Permian Volksrust Formation (Ecca Group, Karoo Supergroup). However, recent Shape files updates (Council for Geosciences, Pretoria) indicates that the proposed waste disposal site is entirely underlain by the Volksrust Formation (Ecca Group, Karoo Supergroup). According to the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of Jurassic dolerite is zero as it is igneous in origin and does not contain fossils while that of the Volksrust Formation is High (Almond and Pether 2008, SAHRIS website).

Numerous impact assessment of the area has been conducted over the years with several site investigations - no fossil heritage was uncovered on the Majuba footprint. Although fossil heritage in this area is uncommon, fossil finds would be significant if found.

As the Geology and Palaeontology of the proposed layout alternatives is similar there would be no preferences on the grounds of palaeontological fossil heritage for any specific alternative layout under consideration. An overall low palaeontological sensitivity is allocated to the development footprint. It is therefore considered that the proposed development is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations, the **Chance Find Protocol** must be implemented by the Environmental Control Officer (ECO) in charge of this development. These discoveries ought to be protected (if possible, *in situ*) and the ECO must report the findings to SAHRA

(Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

Table 2: Impact Summary

Environmental parameter	**Issues**	**Rating prior to mitigation**	**Average**	**Rating post mitigation**	**Average**
Loss of fossil heritage Layout alternative A -	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-56	Negative medium impact	-28	Negative low impact
Layout alternative B -	Destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study	-56	Negative medium impact	-28	Negative low impact

The construction and operation of the Waste Disposal Site at the Eskom Majuba Power Station (Alternative A and B) is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area.

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1 INTRODUCTION

Majuba Power Station is currently undertaking an Environmental Impact Assessment (EIA) for a proposed general waste disposal facility. The scoping phase began in late 2017 and has now lapsed. Therefore Majuba Power Station has had to restart the process. The scoping report was finalised and submitted to the Department of Forestry, Fisheries and the Environment (DFFE) in January 2022. The previous Palaeontological Impact assessment was conducted by Dr Heidi Fourie.

Fourie, H., 2017. Palaeontological Impact Assessment (PIA), Phase 1 Field Study of the suitability of the Construction and Operation of the New General Waste Disposal Site at Eskom Majuba Power Station on Portion 1, 2 and 6 of the Farm Witkoppies 81-HS, Gert Sibande District Municipality, Dr Pixley Ka Seme Local Municipality within the Mpumalanga Province

Currently two site alternatives are investigated for this project and thus this report has been commissioned to update the previous report and to evaluate the both Alternatives A and B (Figure 1-2).

The following information was provided by Savannah Environmental (Pty) Ltd

Eskom Majuba Power Station is proposing the development of a new general waste disposal site and associated infrastructure on a site located approximately 13km southwest of Amersfoort and 40km north-northwest of Volksrust, within jurisdiction of the Dr Pixley Ka Isaka Seme Local Municipality, which forms part of the Gert Sibande District Municipality in the Mpumalanga Province.

Two (2) alternative sites are being considered for establishment of the general waste disposal site, namely Alternative A, located on Portion 6 of the Farm Witkoppies 81HS and Alternative B, located on Portions 1 and 2 of the Farm Witkoppies 81HS. Both sites are contained within Eskom-owned land.

A project site, with an extent of ~866ha has been identified by Eskom Majuba Power Station as a technically feasible site for the development of a new general waste disposal site. A development footprint of ~6ha has been identified within the project site by the proponent for the development. The 6ha will accommodate the actual landfill, together with the associated infrastructure that will be required for the operation of the site.

1.1 Infrastructure

Infrastructure associated with the new general waste disposal site will include the following:

» Fencing with appropriate signage.

» An adequate access road (gravel or surfaced).

» An access control gate.

» A guard house with an ablution facility.

» A conservancy tank connected to the ablution facility.

» Covered parking facilities.

» A designated area for parking and servicing of plant and machinery.

» Sorting and storage facilities for recyclables.

» Adequate water and electricity connection from the existing rising mains.

» Stormwater drainage network and a stormwater evaporation pond for the stormwater entering the site

through the waste body.

» A leachate management system and a leachate evaporation pond.

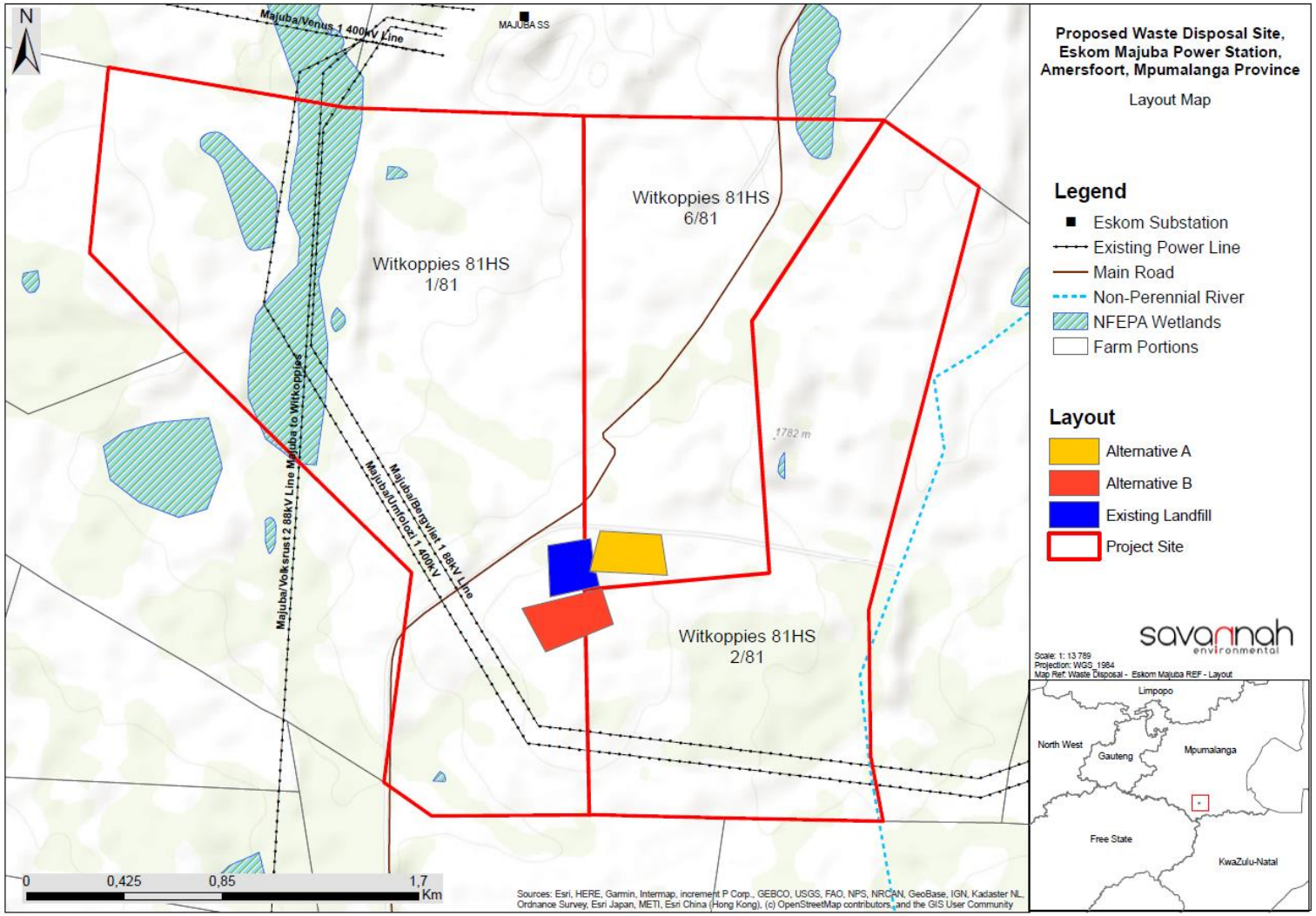


Figure 1: Layout map of the proposed Waste Disposal Site, Eskom Majuba Power Station, Amersfoort, Mpumalanga Province.

Figure 2: Site locality for the proposed Waste Disposal Site, Eskom Majuba Power Station, Amersfoort, Mpumalanga Province. Alternative sites are indicated by labels.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

3 LEGISLATION

3.1 NATIONAL HERITAGE RESOURCES ACT (25 OF 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act, 1999 (Act No 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- NEMA
- NHRA
- MPRDA
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23

- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50
- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

The NEMA (No 107 of 1998) states that an integrated EMP should (23:2 (b)) "*…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*".

The following PIA has been compiled according to legislative requirements, EIA rating standards as well as SAHRA policies.

Palaeontological heritage is extraordinary and non-renewable and is protected by the NHRA. Palaeontological resources may not be broken, unearthed, moved, or destroyed by any development without prior assessment and without a permit from the appropriate heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m² in extent.

or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The aim of a Palaeontological Impact Assessment (PIA) is to decrease the effect of the development on potential fossils at the development site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the objective of the PIA is: 1) identifying the palaeontological importance of the rock formations in the development footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) explain the **impact** on fossil heritage; and 4) suggesting how fossil heritage might be protected.

The palaeontological status of rock sections is calculated as well as the possible impact of the development on fossil heritage by a) the palaeontological importance of the rocks, b) development type and c) how much bedrock is removed.

When areas of moderate to high palaeontological sensitivity is present in the footprint a field-based assessment is necessary. The desktop and the field survey of the exposed rock determine the impact significance of the planned development. On this outcome recommendations for further studies or mitigation are made. Destructive impacts on palaeontological heritage usually only occur during the construction phase while the excavations will change the current topography and destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation may occur during construction or precede construction when potentially fossiliferous bedrock is uncovered. Mitigation comprises the collection and recording of fossils. Preceding excavation of any fossils a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied properly, our knowledge of local palaeontological heritage may be increased, and a positive impact is possible.

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements.
- Submit a comprehensive overview of all appropriate legislation, guidelines.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification of sensitive areas to be avoided (providing shapefiles/kml's) in the proposed development.
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

5 BACKGROUND TO THE GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed Waste Disposal Site at the Eskom Majuba Power Station (Amersfoort, Mpumalanga Province) is depicted on the 1:250 000 Frankfort 2827 Geological map (Muntingh, 1987) (Council for Geoscience, Pretoria) (Figure 3). This Map indicates that the layout alternatives are primarily underlain by Jurassic dolerite (Jd, red) while surrounding areas are underlain by potentially fossiliferous sedimentary rocks of the Early Permian Volksrust Formation (Pvo, orange) (Ecca Group, Karoo Supergroup). However, recent Shape files (Council for Geosciences, Pretoria) indicate that the proposed waste disposal site is entirely underlain by the Volksrust Formation (Ecca Group, Karoo Supergroup) (Figure 4).

The Volksrust Formation forms part of the 16 Formations of the Ecca Group. The Volksrust formation is mostly an argillaceous (contains clay) unit which intefingers with the underlying Vryheid Formation and overlying Beaufort Group. North of Bloemfontein (about 120 km), the Formation is about 380 m thick, gradually thinning to about 250 m in the east and 100 m in the north of the basin (Ravener-Smith et al 1988b). This formation comprises of black to grey silty shale. Reworked soils and sediments of silt and sandstone lenses are usually thin towards the upper and lower boundaries. The upper and lower margins of this formation probably have been deposited in lagoonal to lucastrine and shallow coastal embayment environments. Carbonate and thin phosphate beds as well as concretions are common in this Formation. The Volksrust formation probably represents a transgressive open shelf series which basically consists of mud deposited from suspension. This could be attributed to the large lateral extent as well as the thickness and fine-grained lithology (Cairncross et al 1998).

Kent (1980) noted that this formation contains significant fossils, but they are rarely recorded. The formation is characterized by the occurrence of plant fossils (*Phyllotheca australis; Raniganjia kilburnensis; Schizoneura africana; Glossopteris spp*.), and represents the glossopterids, cordaitaleans and possibly other seed ferns (Bamford 2003; Claassen, 2014). This Formation is also known for its low diversity trace fossil assemblage (Tavener-Smith, et al., 1988) and various organic microfossils. Macrofaunal remains include various insects (Ponomarenko and Mostovski, 2005; Van Dijk, 1981). The first reported discovery of the bivalve, *Megadesmus* in Africa is described from the Late Permian Volksrust Shale Formation, in the north-eastern Karoo Basin (Cairncross, et al, 2005).

Dolerite outcrops are of no palaeontological significance since these are high temperature igneous rocks. Dolerite outcrops in the area have altered the local sediments of the Volksrust Formation thermally and therefore reduce the potential of palaeontological heritage in these sediments.

According to the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of Jurassic dolerite is zero as it is igneous in origin and does not contain fossils while that of the Volksrust Formation is High (Figure 5, Almond and Pether 2008, SAHRIS website). Numerous impact assessment of the area has

been conducted over the years with several site investigations (See Section 7 as well as References) and no fossils were found on the Majuba Footprint. Although fossil heritage in this area is uncommon, fossil finds would be significant if uncovered. A chance find protocol is added to this report.

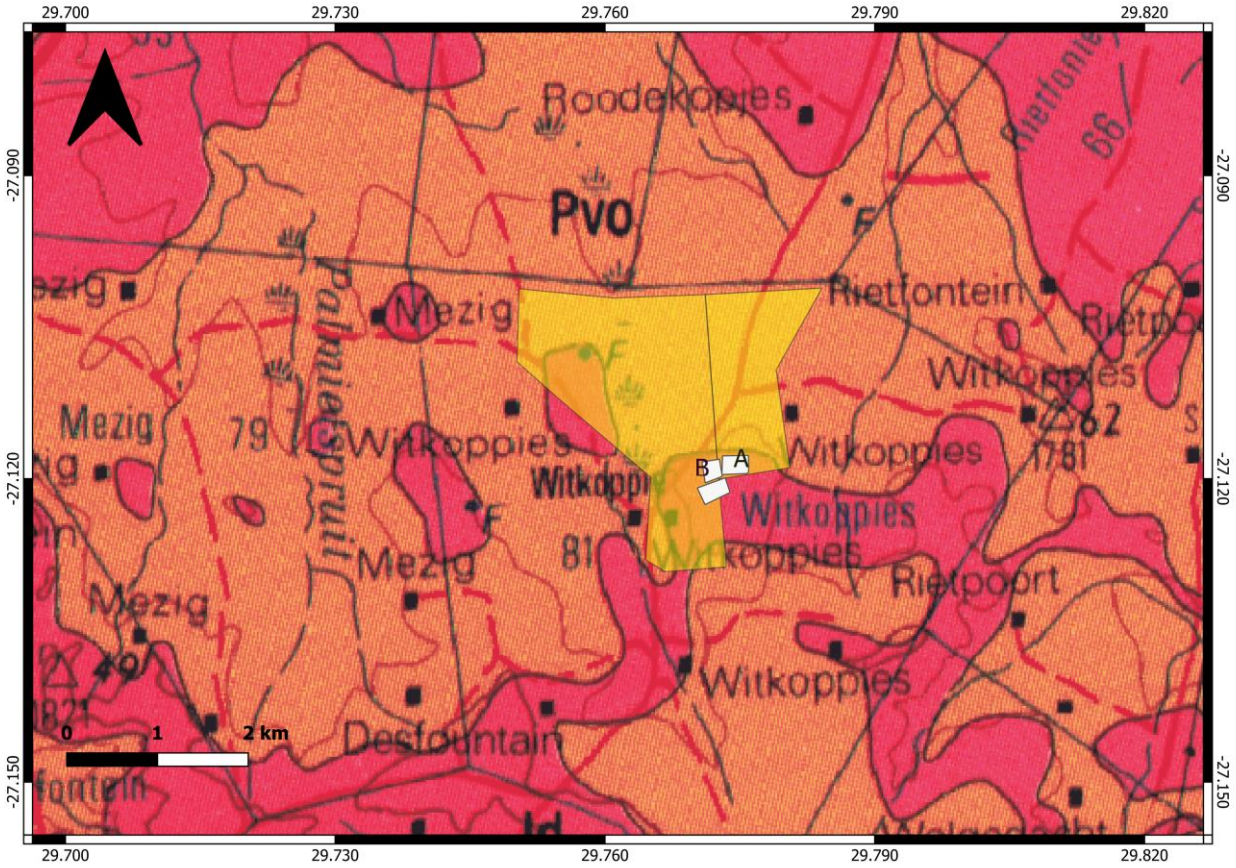
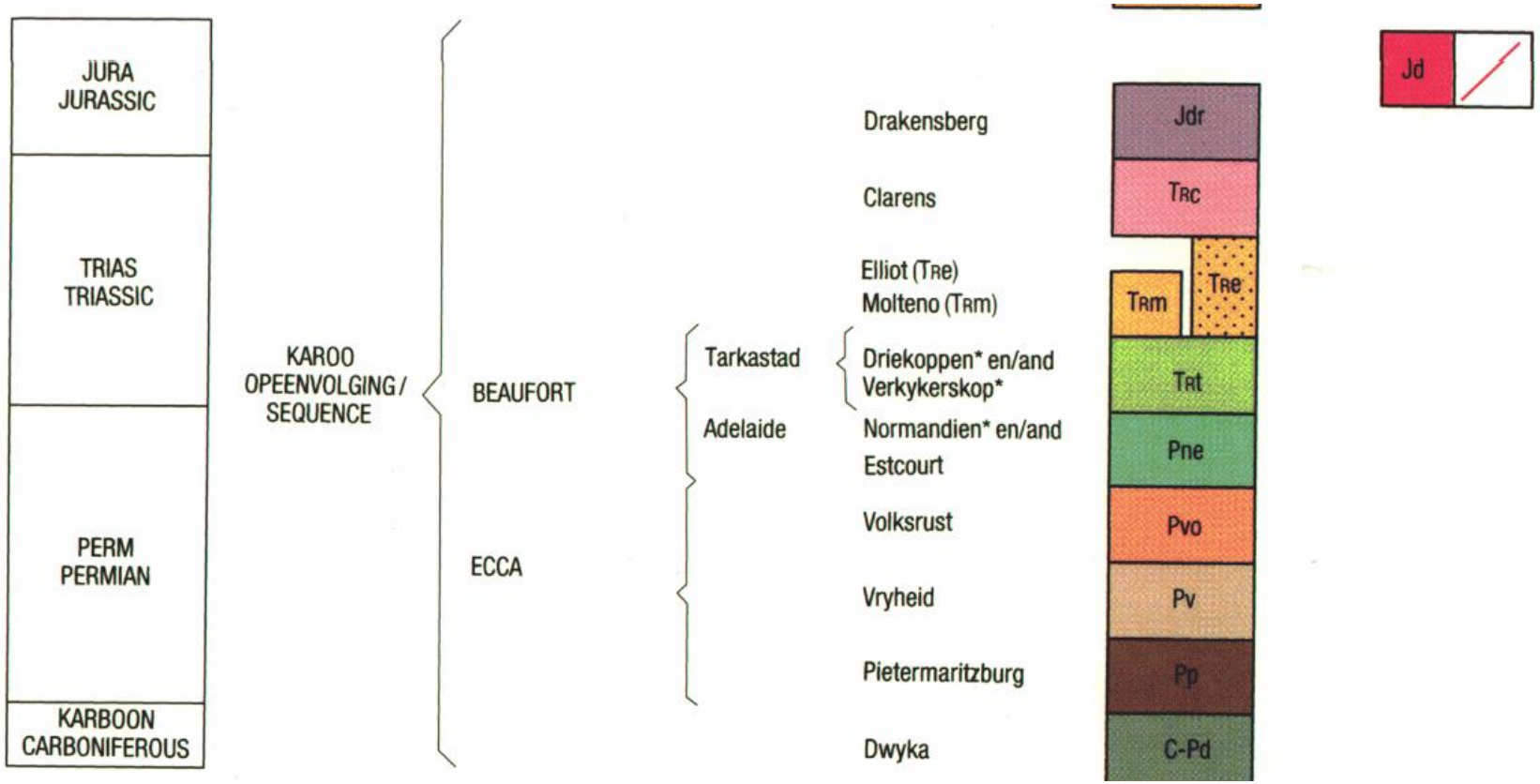


Figure 3: Extract of the 1:250 000 Frankfort 2827 Geological map (1987) (Council of Geoscience, Pretoria) indicating the proposed development in white. The development is underlain by Jurassic Karoo (Jd-dark red), while the area around the development is underlain by the Volksrust Formation (Ecca Group, Karoo Supergroup).

Table 3: Legend of the 1:250 000 Frankfort 2827 Geological map (1987) (Council of Geoscience, Pretoria)



Pvo –. Volksrust Formation, Ecca Group, Karoo Supergroup Bluish-grey or dark-grey mudstone and shale, subordinate siltstone (Permian.

Jd – Dolerite (red). Jurassic.

⊥12 – Strike and dip of bed.

Mining Activities: C – Coal.

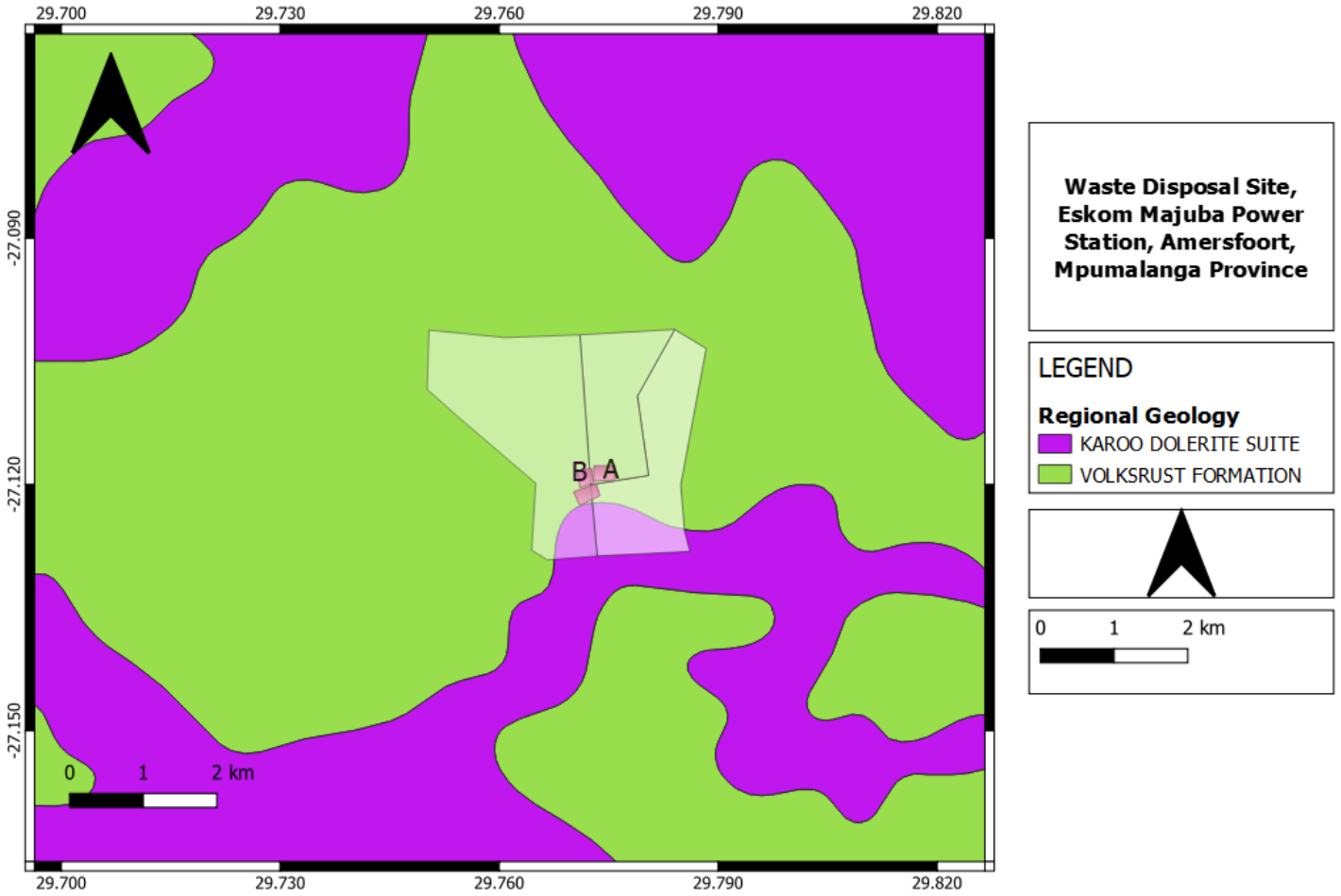


Figure 4: Shape files indicating the surface Geology of the proposed development and surrounding areas. The proposed development is underlain by the Volksrust Formation (Ecca Group, Karoo Supergroup).

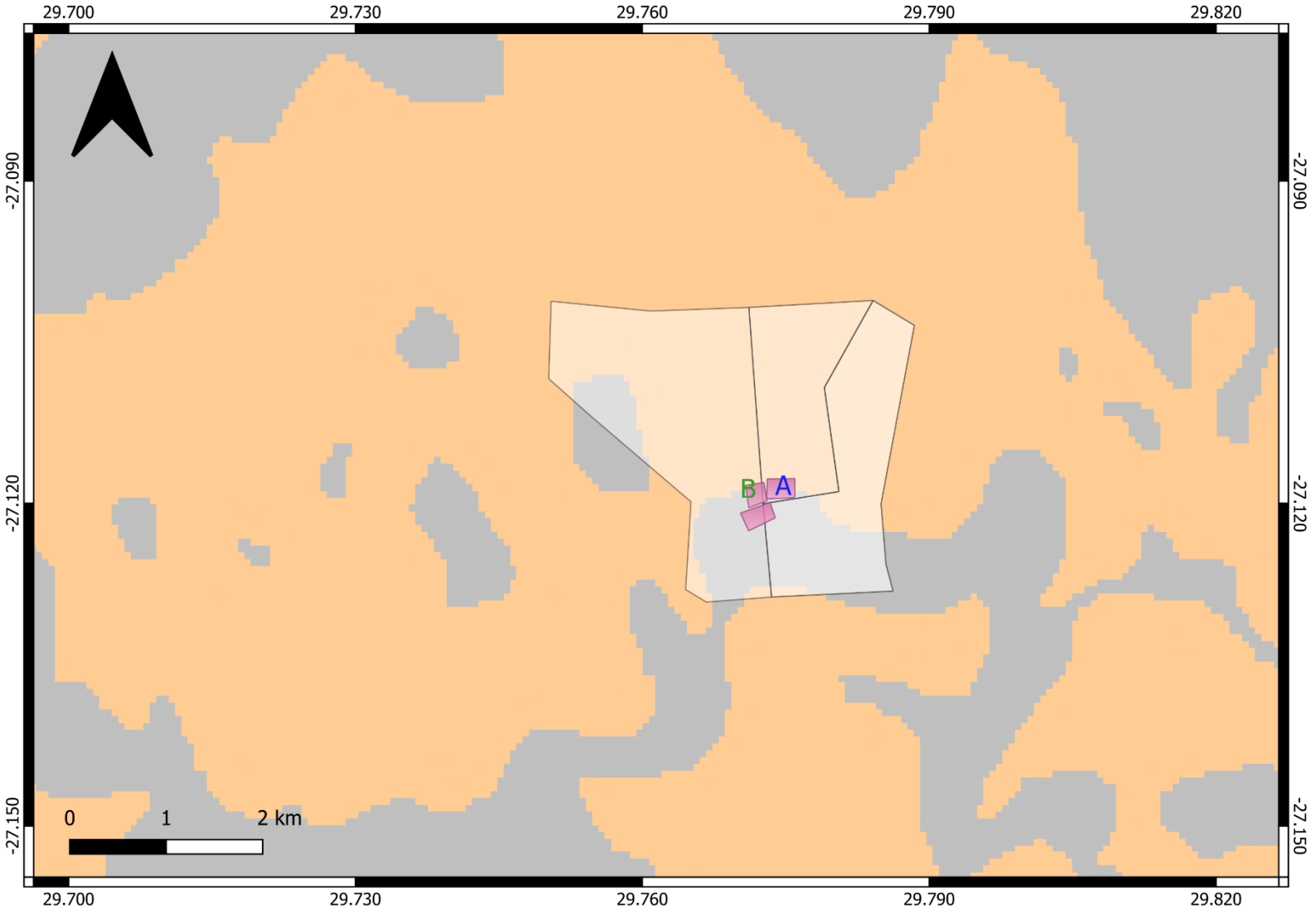


Figure 5: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences). Location of the proposed alternative layouts is indicated pink.

According to the SAHRIS Palaeosensitivity map (Figure 5**)** the proposed development is underlain by sediments with a High (orange) and zero (grey), Palaeontological Sensitivity.

Table 4: SAHRIS Palaeontological Sensitivity

Colour	**Sensitivity**	**Required Action**
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/YELLOW	**HIGH**	**desktop study is required and based on the outcome of the desktop study; a field assessment is likely**
GREEN	MODERATE	desktop study is required
BLUE	LOW	no palaeontological studies are required however a protocol for finds is required
GREY	**INSIGNIFICANT/ZERO**	**no palaeontological studies are required**
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

The SAHRIS Palaeosensitivity map (Figure 5) indicates that the proposed development is underlain by sediments with a Very High (red) Palaeontological Sensitivity. The colours on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Eskom Majuba Waste Disposal Site and associated infrastructure is located approximately 13km southwest of Amersfoort and 40km north-northwest of Volksrust, within jurisdiction of the Dr Pixley Ka Isaka Seme Local Municipality, which forms part of the Gert Sibande District Municipality in the Mpumalanga Province.

7 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile a desktop study and includes Palaeontological Impact Assessment reports in the same area, aerial photos, and Google Earth images, topographical as well as geological maps.

7.1 Assumptions and limitations

The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area that is at present undocumented. When using similar Assemblage Zones and geological formations for Desktop studies it is generally **assumed** that exposed fossil heritage is present within the footprint. The accuracy of a desktop will thus be improved by a field-assessment.

8 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984);
- 1:250 000 Frankfort 2827 Geological map (1987) (Council of Geoscience, Pretoria)
- Shape files obtained from the Council of Geoscience, Pretoria
- A Google Earth map with polygons of the proposed development was obtained from Savannah
- PIAs surrounding the Majuba Power Station includes (Bamford 2019; Butler 2015; Fourie 2017; Millsteed 2014).

9 ASSESSMENT METHODOLOGY

Direct, indirect and cumulative impacts of the impacts identified above will be assessed according to the following standard methodology:

- The **nature** which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent** wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration** wherein it will be indicated whether:
    - The lifetime of the impact will be of very short duration (0 - 1 years) – assigned a score of 1;
    - The lifetime of the impact will be of short duration (2 - 5 years) – assigned a score of 2;
    - Medium-term (5 - 15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.
- The **magnitude** quantified on a scale from 0 - 10 where 0 is small and will have no effect on the environment, 2 is minor and will result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease) and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 - 5 where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but of low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance** which shall be determined through a syntheses of the characteristics described above and can be assessed as low, medium or high; and
- The **status**, which is described as positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

$S = (E + D + M) \times P$

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area);
- 30 – 60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated); and
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9.1 IMPACT ASSESSMENTS

An assessment of the impact significance of the proposed Majuba Waste Disposal Facility is presented here:

9.2 Nature of the impact

The excavations and site clearance of the Majuba Waste Disposal Facility will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may destroy or permanently seal-in fossils at or below the ground surface that will no longer be available for scientific research. According to the Geology of the site, the Palaeontological Significance ranges from zero to high.

9.3 Sensitive areas

The site proposed for the Majuba Waste Disposal Facility is situated about 13km southwest of Amersfoort and 40km north-northwest of Volksrust, in the Mpumalanga Province. The proposed development is underlain by Karoo Dolerite (according to the 1:250 000 Geological Map) with a Zero Palaeontological Sensitivity and the Volksrust Formation (Ecca Group) with a High Palaeontological Sensitivity according to the Shape Files.

However, dolerite outcrops are of no palaeontological significance since these are high temperature igneous rocks. Dolerite outcrops have altered the local sediments of the

Volksrust Formation thermally and therefore reduce the potential of palaeontological heritage in these sediments.

9.4 Geographical extent of impact

The impact on fossil materials and thus palaeontological heritage will be limited to the construction phase when new excavations into fresh potentially fossiliferous bedrock take place. The extent of the area of potential impact is thus restricted to the project site and therefore categorised as **local**.

9.5 Duration of impact

The expected duration of the impact is assessed as potentially permanent to long term. 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 **permanent.**

9.6 Potential significance of the impact

Should the project progress without care to the prospect of fossils being present at the proposed site, the subsequent damage, destruction or unintentional replacement of any affected fossils will be **permanent and irreversible**. Fossils occurring in the development area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

9.7 Severity / benefit scale

The development of the proposed Majuba Waste Disposal Facility is **beneficial** on not only a local level, but regional and national levels as well.

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils that were hidden beneath the surface exposures and, as such, would have remained unknown to science.

9.8 Intensity

Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as low.

9.9 Probability of the impact occurring

Numerous Palaeontological Field Base Assessments have not uncovered any fossil heritage and thus the probability of significant impacts on palaeontological heritage during the construction phase are low.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

10.1 Mitigation

If fossil material exists within the proposed development area, any negative or detrimental impact upon it could be mitigated by describing and collecting well-preserved fossils by a professional palaeontologist. This should take place after vegetation clearance but *before* the ground is levelled for construction. Excavation of fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. In the event that an excavation is impossible or inappropriate, the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.

10.2 Degree to which the impact can be mitigated

Recommended mitigation of the damage and destruction of fossil heritage within the proposed development area would involve the collection and describing of fossils within the development footprint by a professional palaeontologist. These actions would take place after initial vegetation clearance has taken place but *before* the ground is levelled for construction.

10.3 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. From a scientific point of view, all well-documented records and palaeontological studies of any fossils exposed during construction would represent a positive impact. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of suitable damage mitigation procedures. If damage mitigation is properly undertaken the benefit scale for the project will lie within the beneficial group.

10.4 Degree to which the impact may cause irreplaceable loss of resources

Stratigraphic and geographical distribution of fossils in the proposed development site is expected to be of low palaeontological sensitivity.

Table 5: Impact table of the construction phase of the Majuba Waste Disposal Facility alternative layout A and B

Nature: *T*he excavations and clearing of vegetation during the construction phase of the Majuba Waste Disposal Facility and associated infrastructure will consist of digging into the superficial sediment cover as well as underlying deeper bedrock. These excavations will change the existing topography and may possibly destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research. Impacts on Palaeontological Heritage are only likely to happen within **the construction phase**. No impacts are expected to occur during the operation phase or decommissioning phase.				
	Alternative A		**Alternative B**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)	Permanent (5)	Permanent (5)
Magnitude	High (8)	High (8)	High (8)	High (8)
Probability	Highly Probable (4)	Improbable (2)	Highly Probable (4)	Improbable (2)
Significance	**Medium (56)**	**Low (28)**	**Medium (56)**	**Low (28)**
Status (positive or negative)	Negative	Neutral	Negative	Neutral
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes	Yes	Yes
Can impacts be mitigated?	Yes		Yes	

Mitigation/Enhancement Measures:

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the Environmental Control Officer (ECO) or site manager. The ECO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509.

Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized, the fossil may be collected with extreme care by the ECO (or site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area. The ECO will close off the chance find procedure and would be required to implement any requirements issued by the Authority and to add it to the operational management plan

Residual Risk: *Loss of Fossil Heritage*

Table 6: Comparative assessment of Alternatives

GENERAL WASTE DISPOSAL SITE AT THE ESKOM MAJUBA POWER STATION		
Alternative	**Preference**	**Reasons**
Alternative A	Acceptable	Same Geology and thus same Palaeontology
Alternative B	Acceptable	Same Geology and thus same Palaeontology

Table 7: *Cumulative impact table:*

Nature: Loss of Fossil Heritage

Nature:

Loss of Fossil Heritage		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Low (1)	Low (1)
Duration	Medium-term (3)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (12)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		

Mitigation:

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ECO or site manager. The ECO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds

must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.

- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ECO (or site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area. The ECO will close off the chance find procedure and would be required to implement any requirements issued by the Authority and to add it to the operational management plan

Table 8: Recommendations Concerning Fossil Heritage Management During the Construction Phase

OBJECTIVE: Prevent the loss of Palaeontological Heritage			
Project component/s	Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography. The proposed development consists of the construction of a Waste Disposal Site and associated infrastructure.		
Potential Impact	Destroy or permanently close-in fossils at or below the ground surface that are then no longer available for research.		
Activity/risk source	Activities associated with the construction of the project.		
Mitigation: Target/Objective	Protection of identified fossils uncovered during the construction phase.		
Mitigation: Action/control		**Responsibility**	**Timeframe**
Mitigation comprises of the collection and recording of fossils as well as obtaining data of the surrounding sedimentary matrix within the proposed development footprint by a palaeontologist. This should take place after the preliminary vegetation removal but *before* the ground is levelled for construction. Excavation of this fossil		Environmental Manager or ECO and specialist	Construction phase

heritage will require a permit from the South African Heritage Resource Agency (SAHRA) and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA. These recommendations should be incorporated into the Environmental Management Programme for the Waste Disposal Site.		

11 FINDINGS AND RECOMMENDATIONS

The proposed layout alternatives are primarily underlain by Jurassic dolerite while surrounding areas are underlain by potentially fossiliferous sedimentary rocks of the Early Permian Volksrust Formation (Ecca Group, Karoo Supergroup). However, recent Shape files updates (Council for Geosciences, Pretoria) indicates that the proposed waste disposal site is entirely underlain by the Volksrust Formation (Ecca Group, Karoo Supergroup). According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database the Palaeontological Sensitivity of Jurassic dolerite is zero as it is igneous in origin and does not contain fossils while that of the Volksrust Formation is High (Almond and Pether 2008, SAHRIS website).

Numerous impact assessments of the area have been conducted over the years with several site investigations - no fossils heritage was uncovered on the Majuba footprint. Although fossil heritage in this area is uncommon, fossil finds would be significant if found.

As the Geology and Palaeontology of the proposed layout alternatives is similar there would be no preferences on the grounds of palaeontological fossil heritage for any specific alternative layout under consideration. An overall low palaeontological sensitivity is allocated to the development footprint. It is therefore considered that the proposed development is deemed appropriate and will not lead to detrimental impacts on the palaeontological reserves of the area. It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the Environmental Control Officer (ECO) in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO must report to SAHRA (Contact

details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

12 CHANCE FIND PROTOCOL

A following procedure will only be followed if fossils are uncovered during excavation.

12.1 LEGISLATION

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA).** According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ECO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

12.2 CHANCE FIND PROCEDURE

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ECO or site manager. The ECO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ECO (or site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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APPENDIX 1:

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION: B.Sc Botany and Zoology, 1988

University of the Orange Free State

B.Sc (Hons) Zoology, 1991

University of the Orange Free State

Management Course, 1991

University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009

University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

Registered as a PhD fellow at the Zoology Department of the UFS

2013 to current

Dissertation title: A new gorgonopsian from the uppermost D*aptocephalus Assemblage Zone*, in the Karoo Basin of South Africa

MEMBERSHIP

Palaeontological Society of South Africa (PSSA)	2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part-time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–currently

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