

**PALAEONTOLOGICAL FIELD ASSESSMENT OF THE PROPOSED CONSTRUCTION  
OF THE ZONNEBLOEM SWITCHING STATION (132/22KV) AND TWO LOOP-IN  
LOOP-OUT POWER LINES (132KV) IN THE MPUMALANGA PROVINCE**

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## EXECUTIVE SUMMARY

Eskom Holdings SOC Limited has appointed Savannah Environmental (Pty) Ltd to undertake the Basic Assessment process for the construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. The proposed development site is located on the

- Remaining Extent of the Farm Patattafontein 412;
- Remaining Extent of the Farm Zevenfontein 415; and
- Portion 4 of the Farm Gemsbokfontein 411

The development site is located within the Steve Tshwete Local Municipality and within the greater Nkangala District Municipality. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is key to detect the presence of fossil material within the proposed development footprint and study area and it is thus necessary to evaluate the impact of the construction and operation of the development site on the palaeontological resources.

The proposed actual footprint is primarily underlain by the Vryheid Formation of the Permian Ecca Group while the study area cuts into a small part of the and the Damwal Formation (Rooiberg Group, Bushveld Complex) while the project site is underlain by Rashoop Granophyre Suite (Bushveld Complex).

The Vryheid Formation (Ecca Group) is world renowned for the occurrence of coal beds formed by the accumulation of plant material. This Formation is also characterised by its trace fossil assemblages of the non-marine *Mermia* Ichnofacies, fish and small crustaceans as well as insect fossils track ways. The unique *Mesosaurus* reptile may also be present. Trace fossils, low in diversity, are abundantly found within the Formation. Rare insects, possible conchostracans, non-marine bivalves and fish scales are also present. This Formation has a very high Palaeontological sensitivity. The Damwal Formation (Rooiberg Group) and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

During a field survey of the development footprint, no fossiliferous outcrops were found. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the project and associated infrastructure will be of a low significance in palaeontological terms. As the geology of the road alternatives are the same the impacts are expected to be the same and there is thus no preferred access road alternative. It is therefore considered that the construction and operation Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province as well as the both road alternatives is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Therefore, the construction and operation of the project (and its associated impacts) may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

Irrespective of the uncommon occurrence of fossils a solitary fossil may be of scientific value as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the study area. In the event that fossil remains are uncovered during any phase of construction, either on the surface or unearthed by new excavations and vegetation clearance, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (if possible *in situ*) and the ECO must report to SAHRA so that appropriate mitigation (e.g. recording, collection) can be carry out by a professional paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies proposed by SAHRA.

<b>Palaeontological Sensitivity</b>	<b>Group</b>	<b>Group/Formation</b>	<b>Lithology</b>	<b>Period</b>	<b>Fossils /Exposures</b>
Almond et al (2008) and Groenewald et al., (2014)					
High to very high Palaeontological sensitivity/vulnerability	Ecca	Vryheid Formation	Deltaic mudrocks and sandstones, coastal and fluvial deposits, occasional coal seams	Permian	Glossopteris Flora (lycopods, scarce ferns, horsetails cordaitaleans, conifers and ginkgoaleans), rare fossil wood, palynomorphs, trace fossils, rare insects, possible conchostracans, non-marine bivalves and fish scales.
Very Low Palaeontological sensitivity/vulnerability.	Rashoop Granophyre Suite	Bushveld Complex	Igneous rock		No fossils recorded
Very Low Palaeontological sensitivity/vulnerability	Damwal Formation -	Rooiberg Group	Igneous rock		No fossils recorded

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## **1 INTRODUCTION**

**Savannah Environmental (Pty) Ltd** has been appointed as the independent Environmental Consultants by Eskom Holdings SOC Ltd for the undertaking of a Basic Assessment (BA) process. Eskom Holdings SOC Ltd proposes the construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines from the existing Mafube/Pan Traction power line approximately 20 km east of Middelburg (Fig.1). Each power line will be 500m in length. The infrastructure associated with the switching station will include a new access road and a communication tower. Two access road alternatives are proposed and assessed within this study.

Two alternative alignments for the access road are being considered:

- Alternative A: Access road will be up to 8m wide and approximately 990m in length.
- Alternative B: Access road will be up to 8m wide and approximately 805m in length.

The proposed development is located on the Remaining Extent of the Farm Patattafontein 412; Remaining Extent of the Farm Zevenfontein 415; and Portion 4 of the Farm Gemsbokfontein 411.



**Figure 1:** Google Earth Image (2018) of the location of the proposed Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines from the existing Mafube/Pan Traction power line approximately 20 km east of Middelburg. Scale bar represents 4.03 km.

## 2 LEGISLATION

### **NATIONAL HERITAGE RESOURCES ACT (ACT 25 OF 1999)**

Cultural Heritage in South Africa, includes all heritage resources, are protected by the National Heritage Resources Act (Act 25 of 1999). 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”**. Palaeontological heritage is unique and non-renewable and is protected by the above mentioned Act. Palaeontological resources may not be unearthed, moved, broken or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority.

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

### **ACCORDING TO SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 1999, DEALING WITH ARCHAEOLOGY, PALAEOLOGY AND METEORITES:**

**35.** (1) Subject to the provisions of section 8, the protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority: Provided that the protection of any wreck in the territorial waters and the maritime cultural zone shall be the responsibility of SAHRA.

(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State. The responsible heritage authority must, on behalf of the State, at its discretion ensure that such objects are lodged with a museum or other public institution that has a collection policy acceptable to the heritage resources authority and may in so doing establish such terms and conditions as it sees fit for the conservation of such objects.

(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.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or



(d) Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) Serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) Carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and (d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

(6) The responsible heritage resources authority may, after consultation with the owner of the land on which an archaeological or palaeontological site or a meteorite is situated, serve a notice on the owner or any other controlling authority, to prevent activities within a specified distance from such site or meteorite.

(7) (a) Within a period of two years from the commencement of this Act, any person in possession of any archaeological or palaeontological material or object or any meteorite which was acquired other than in terms of a permit issued in terms of this Act, equivalent provincial legislation or the National Monuments Act, 1969 (Act No. 28 of 1969), must lodge with the responsible heritage resources authority lists of such objects and other information prescribed by that authority. Any such object which is not listed within the prescribed period shall be deemed to have been recovered after the date on which this Act came into effect. (b) Paragraph (a) does not apply to any public museum or university. (c) The responsible authority may at its discretion, by notice in the *Gazette* or the *Provincial Gazette*, as the case may be, exempt any institution from the requirements of paragraph (a) subject to such conditions as may be specified in the notice, and may by similar notice withdraw or amend such exemption.

(8) An object or collection listed under subsection (7) — (a) Remains in the ownership of the possessor for the duration of his or her lifetime, and SAHRA must be notified who the successor is; and (b) must be regularly monitored in accordance with regulations by the responsible heritage authority.

## HERITAGE RESOURCES MANAGEMENT

**38.** (1) Subject on 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—(i) exceeding 5 000 m<sup>2</sup> in extent; or (ii) involving three or more existing erven or subdivisions thereof; or (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority (d) the re-zoning of a site exceeding 10 000 m<sup>2</sup> in extent; (e) or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

### 3 OBJECTIVE

The **objective of a Palaeontological Impact Assessment is to determine the impact of the development on potential palaeontological material** at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment are: 1) to identify the palaeontological importance of the exposed and subsurface rock formations in the development footprint 2) to evaluate the palaeontological importance of the formations 3) to determine the impact of the development on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontological desktop study is compiled, the potentially fossiliferous rocks (i.e. groups, formations, etc.) present within the study area are established from 1:250 000 geological maps. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within each rock section is obtained from previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations specifically in areas close to the development area). The palaeontological importance of each rock unit of the development area is then calculated. The possible impact of the proposed development footprint on local fossil heritage is established on the following criteria: 1) the palaeontological importance of the rocks and 2) the type and scale of the development footprint and 3) quantity of bedrock excavated.

In the event that rocks of moderate to high palaeontological sensitivity are present within the study area, a field-based assessment by a professional palaeontologist is required. Based on both the desktop data and field examination of the sedimentary rock exposures, the impact significance of the planned development is measured with recommendations for any further studies or mitigation. In general destructive impacts on palaeontological heritage only occur during construction. The excavations will

transform the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

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

## **4 GEOLOGICAL AND PALAEOLOGICAL HISTORY**

The proposed actual footprint is primarily underlain by the Vryheid Formation of the Permian Ecca Group while the study area cuts into a small part of the Damwal Formation (Rooiberg Group, Bushveld Complex) while the project site is underlain by Rashoop Granophyre Suite (Bushveld Complex) (Fig. 2).

### **4.1 GEOLOGY**

#### **VRYHEID FORMATION**

The Vryheid Formation forms part of the north eastern formations of the Ecca Group. The lithofacies of this Formation is mostly deltaic mudrocks and sandstones although non-deltaic cycles have been reported.

The Vryheid Formation is characterized by fine to coarse sandstone and siltstone sediments. The dark coloured siltstones can be accredited to the existence of carbon enrichment and coal beds. These sediments most probably were deposited on a sandy shoreline that stretched out beyond massive swamplands. In these swamps, plants accumulated and formed the coal deposits that are mined today (Johnson et al, 2006).

#### **DAMWAL FORMATION**

According to SACS (1980) the Rooiberg Group comprised of the Selons River Formation which was split in the Klipnek Member and the Doornkloof Member. Schweitzer *et al.* (1995, and followed in this study) correlated the Doornkloof and Klipnek Members of the Selons River Formation (SACS, 1980) with the Schrikkloof and Kwaggasnek Formations, thus allowing the Selons River Formation and its members to be terminated. The Kwaggasnek, Schrikkloof, Damwal and Dullstroom Formations are now recognised as the Rooiberg Group and contains volcanic units. Metamorphosed sediments of quartzites, sandstones, mudrocks and cherts are present which is mainly fluvial in origin. The Damwal Formation consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

#### **RASHOOP GRANOPHYRYRE SUITE**

The Rashed Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

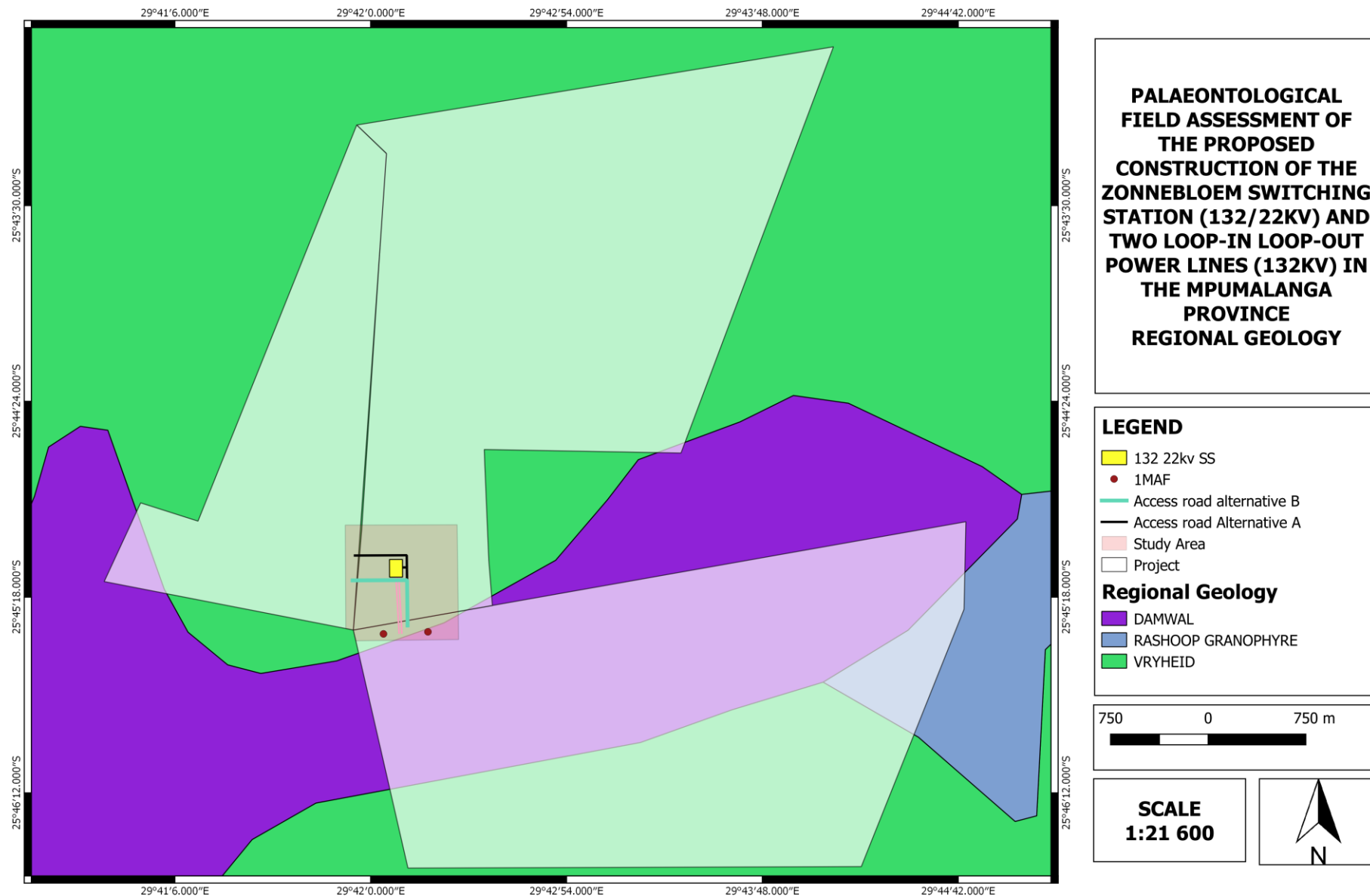
## 4.2 PALAEOLOGICAL HERITAGE

The Vryheid Formation (Ecca Group) is world renowned for the occurrence of coal beds formed by the accumulation of plant material. This formation has a Very high Palaeontological Sensitivity). Bamford (2011) reported that only a small amount of data have been published on the potentially fossiliferous plant deposits of the Vryheid Formation and that most likely well preserved material are present around coal mines while in other areas the exposures are poor and of little interest. When plant fossils do occur they are usually abundant. Plant fossils of the Vryheid Formation include Glossopteris Flora (rich diversity of glossopterids, lycopods, scarce ferns and horsetails, cordaitaleans, conifers and ginkgoaleans), and rare fossil wood which are present with diverse palynomorphs. In recent years plant fossils have been under-collected despite continuing mining activities.

Abundantly found trace fossils with a low diversity are also recovered from the Vryheid Formation as well as rare insects, possible conchostracans, non-marine bivalves and fish scales. This Formation is also characterised by its trace fossil assemblages of the non-marine *Mermia* Ichnofacies and insect fossils track ways. The *Mesosaurus* reptile may also be present.

The Damwal Formation (Rooiberg Group) and Rashed Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

Figure 2 below provides a map of the surface geology within and surrounding the study area.



**Figure 2:** The surface geology of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Each power line will be 500m in length. Associated infrastructure will include a new access road (two alternatives) and a communication tower. The site is underlain by the Vryheid Formation (Ecca Group); the Damwal Formation and the Rashoop Granophyre Suite (Bushveld Complex). Map was drawn by QGIS Desktop 2.18.14.

## **5 GEOGRAPHICAL LOCATION OF THE SITE**

The proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out chickadee power lines (132kV) in the Mpumalanga Province is located on the 1) Remaining Extent of the Farm Patattafontein 412; 2) Remaining Extent of the Farm Zevenfontein 415; and 3) Portion 4 of the Farm Gemsbokfontein 411 (approximately 20 km east of Middelburg). The development site is located within the Steve Tshwete Local Municipality and within the greater Nkangala District Municipality.

## **6 METHODS**

As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted on 10-11 March 2018 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot and by vehicle within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2018), topographical and geological maps were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

### **6.1 Assumptions and limitations**

The accurateness of Palaeontological Desktop Impact Assessments is reduced by old fossil databases that do not always include relevant locality or geological formations. The geology in various remote areas of South Africa may be less accurate because it is based entirely on aerial photographs. The accuracy of the sheet explanations for geological maps is inadequate as the focus was never intended to be on palaeontological material.

The entire South Africa have not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area. Thus, the accuracy of the Palaeontological Impact Assessment will be improved by a field-survey.

## **7 FIELD OBSERVATIONS**

The following photographs were taken on a site visit to the study area proposed for the development of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out chickadee power lines (132kV). Each power line will be 500m in length. The infrastructure associated with the switching station will include a new access road and a communication tower. Two access road alternatives are proposed and assessed in this study.

25° 44' 29"S; 29°40'51"E



25° 43' 09"S; 29°41'55"E



25° 45' 21"S; 29°41'53"E



25° 45' 26"S; 29°42'09"E



25° 45' 22"S; 29°42'32"E



25° 43' 47"S; 29°43'45"E



25° 45' 18"S; 29°41'31"E



25° 44' 55"S; 29°43'50"E





25° 44' 54"S; 29°43'49"E



## 8 ASSESSMENT OF IMPACTS

A basic assessment of the impact significance of the proposed project on local fossil heritage is presented here:

### 8.1 Nature of the impact

Each power line to and from the Zonnebloem Switching Station (132/22kV) will be 500m in length. The infrastructure associated with the switching station will include a new access road and a communication tower. Two access road alternatives are proposed and will be assessed in this study.

The excavations and site clearance of vegetation will consist of significant excavations into the uppermost sediment cover as well as into the underlying bedrock. These excavations will transform the present topography and may disrupt, destroy or permanently close-in fossils that are then unavailable for research.

### 8.2 Geographical extent of impact

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

### 8.3 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**.

### 8.4 Sensitive areas

The **Vryheid Formation** (Ecca Group) is world renowned for the occurrence of coal beds formed by the accumulation of plant material. This Formation is also characterised by its

trace fossil assemblages of the non-marine *Mermia* Ichnofacies, fish and small crustaceans as well as insect fossils track ways. The *Mesosaurus* reptile may also be present. Abundantly found but a low diversity of trace fossils is present, as well as occasional insects, possible conchostracans, non-marine bivalves and fish scales. This Formation has a **very high Palaeontological sensitivity**. The **Damwal Formation and Rашoop Granophyre Suite of the Bushveld Complex** consist of igneous rock which is unfossiliferous and has a very **low palaeontological sensitivity**.

The whole development footprint of the project is underlain by the Vryheid Formation with the south western corner falls in the Damwal Formation (Fig.2).

### **8.5 Potential significance of the impact**

If the project progress without care to the chance of fossils being present at the proposed site with the resultant damage and destruction of any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the study area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

### **8.6 Severity / benefit scale**

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils and would have remained unknown to science.

### **8.7 STATUS**

#### **Probability of the impact occurring**

There is a possibility that fossil heritage will be recorded in the study area. 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**.

#### **Intensity**

The intensity of the impact on fossil heritage is rated as **low** as the possibility of finding fossils in the proposed development footprint is low.

## **9 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS**

### **9.1 Mitigation**

In the event that fossil material does exist within the area proposed for the development any negative impact upon it could be mitigated by recording and sampling of well-preserved fossils by a professional palaeontologist. This should precede vegetation clearance but *before* the ground is levelled for construction. A collecting permit from SAHRA is required before any fossil heritage may be excavated and the material must be housed in an accredited institution.

### **9.2 Degree to which the impact can be mitigated**

The Vryheid Formation (Ecca Group) has a very high Palaeontological sensitivity while the Damwal Formation and Rашoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological

sensitivity. Suggested mitigation of the unavoidable damage and destruction of fossil heritage within the proposed site would involve the recording, and sampling of well-preserved fossils within the development footprint by a professional palaeontologist. This should precede vegetation clearance but *before* the ground is levelled for construction. Yet, the significance of the impact following the mitigation will remain low.

### **9.3 Degree of irreversible loss**

Impacts on fossil heritage are usually irreversible. Well-documented records and other palaeontological studies of any fossils discovered during construction would scientifically signify a positive impact. The probability of a negative impact on the palaeontological heritage of the area can be reduced by carrying out suitable mitigation procedures. With proper mitigation the benefit scale for the project will lie within the beneficial category.

### **9.4 Degree to which the impact may cause irreplaceable loss of resources**

It is thus **possible** that extraordinary fossil material is present on the study area although the chances are slim. By taking a cautionary approach, an insignificant loss of fossil resources is expected.

### **9.5 Cumulative impacts**

The cumulative effect of the development is high as similar developments are present in the area, but the probability of the impact occurring will be low.

There is similar infrastructure within a 10km radius from the project site. These include:

- Mafube 13kV Substation situated ~7,9km south-east of the study area;
- Nitens 132kV Substation ~7,8 km north of the study area
- 132kV Mafube/Pan Traction power line which traverses the southern boundary of the project site;
- 132kV Nitens Trac-Pan Traction power line ~4km west of the study area;
- 132kV Kleindam Traction/Nitens Traction power line ~7,9km south-east of the study area
- 132kV Arnot Traction/Mafube power line ~7,3km north of the study area;
- 275kV Arnot Simplon power line ~7,9km south-east of the study area;
- 400kV Arnot Merensky power line ~7,9km south-east of the study area; and
- 132 kV Derwent Trac-Pan Traction ~10km east of the study area.

## **10 ASSESSMENT OF IMPACTS**

### **10.1 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).

Impacts associated with the switching station, power lines and other infrastructure (excluding access roads)

**Nature:** The excavations and clearing of vegetation during the construction phase 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 disturb, 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 likely to happen only within the construction phase. No impacts are expected to occur during the operation phase or decommissioning phase.

	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Local(1)	Local(1)
<b>Duration</b>	Long term/permanent (5)	Long term/permanent (5)
<b>Magnitude</b>	Minor (2)	Minor (1)
<b>Probability</b>	Improbable (1)	Improbable (1)
<b>Significance</b>	<b>Low (8)</b>	<b>Low (7)</b>
<b>Status (positive or negative)</b>	Negative	Neutral
<b>Reversibility</b>	Irreversible	Irreversible
<b>Irreplaceable loss of resources?</b>	No	No
<b>Can impacts be mitigated?</b>	Not necessary	Not necessary

**Mitigation: Not necessary**

The proposed actual footprint is primarily underlain by the Vryheid Formation of the Permian Ecca Group (which has a very high Palaeontological sensitivity) while the study area cuts into a small part of the Damwal Formation (Rooiberg Group, Bushveld Complex). The project site is underlain by Rashoop Granophyre Suite (Bushveld Complex). The Damwal Formation and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity. The lack of appropriate exposure at the proposed development footprint (including all two road alternatives) indicates that the impact of the development is of low significance in palaeontological terms.

**Residual Risk:**

Loss of Palaeontological Heritage.

Impacts associated with the access roads

**Nature:** The excavations and clearing of vegetation during the construction phase 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

disturb, destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.

Two alternative alignments for the access road are being considered:

- » Alternative A: Access road will be up to 8m wide and approximately 990m in length.
- » Alternative B: Access road will be up to 8m wide and approximately 805m in length.

Impacts on Palaeontological Heritage are likely to happen only within the construction phase. No impacts are expected to occur during the operation phase.

	<b>Alternative A</b>		<b>Alternative B</b>	
	<b>Without mitigation</b>	<b>With mitigation</b>	<b>Without mitigation</b>	<b>With mitigation</b>
<b>Extent</b>	Local(1)	Local(1)	Local(1)	Local(1)
<b>Duration</b>	Long term/permanent (5)	Long term/permanent (5)	Long term/permanent (5)	Long term/permanent (5)
<b>Magnitude</b>	Minor (2)	Minor (1)	Minor (2)	Minor (1)
<b>Probability</b>	Improbable (1)	Improbable (1)	Improbable (1)	Improbable (1)
<b>Significance</b>	<b>Low (8)</b>	<b>Low (7)</b>	<b>Low (8)</b>	<b>Low (7)</b>
<b>Status (positive or negative)</b>	Negative	Neutral	Negative	Neutral
<b>Reversibility</b>	Irreversible	Irreversible	Irreversible	Irreversible
<b>Irreplaceable loss of resources?</b>	No	No	No	No
<b>Can impacts be mitigated?</b>	Yes	Yes	Yes	Yes

**Mitigation: Not necessary**

The site is underlain by the Vryheid Formation (Ecca Group) and Damwal Formation and Rashoop Granophyre Suite of the Bushveld. The Vryheid Formation (Ecca Group) has a very high Palaeontological sensitivity while the Damwal Formation and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity. The lack of appropriate exposure at the proposed development footprint (including all two road alternatives) indicates that the impact of the development is of low significance in palaeontological terms.

**Residual Risk:**

Loss of Palaeontological Heritage.

## ASSESSMENT OF CUMULATIVE IMPACTS

<p><b>Nature:</b> Cumulative impacts on fossil remains preserved at or beneath the ground surface. The proposed development includes the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines from the existing Mafube/Pan Traction power line. Each power line will be 500m in length. The infrastructure associated with the switching station will include a new access road and a communication tower. There are also other similar infrastructure within a 10km radius from the study area.</p>		
	<p><b>Overall impact of the proposed project considered in isolation</b></p>	<p><b>Cumulative impact of the project and other projects in the area</b></p>
<b>Extent</b>	Local (1)	Low (1)
<b>Duration</b>	Permanent (5)	Permanent (5)
<b>Magnitude</b>	Minor (2)	Minor (2)
<b>Probability</b>	Improbable (2)	Improbable (1)
<b>Significance</b>	<b>Low (16)</b>	<b>Low (8)</b>
<b>Status (positive/negative)</b>	Negative	Negative
<b>Reversibility</b>	Low	Low
<b>Loss of resources?</b>	No	No
<b>Can impacts be mitigated?</b>	Yes	Unknown
<p><b>Confidence in findings:</b> High.</p>		
<p><b>Mitigation: Not necessary</b> The site is underlain by the Vryheid Formation (Ecca Group) and Damwal Formation and Rashoop Granophyre Suite of the Bushveld. The Vryheid Formation (Ecca Group) has a very high Palaeontological sensitivity while the Damwal Formation and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity. The lack of appropriate exposure at the proposed development footprint (including all two road alternatives) indicates that the impact of the development is of low significance in palaeontological terms</p>		
<p><b>Residual Risk:</b> Loss of Palaeontological Heritage</p>		

## RECOMMENDATIONS CONCERNING FOSSIL HERITAGE MANAGEMENT DURING THE CONSTRUCTION PHASE

OBJECTIVE: Prevent the loss of Palaeontological Heritage

<b>Project component/s</b>	Damaging impacts on palaeontological heritage occur during the <b>construction</b> phase which will modify the existing topography. The proposed development consists of the construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines from the Mafube/Pan Traction to the Zonnebloem Switching Station. Each power line will be 500m in length. The infrastructure associated with the switching station will include a new access road and a communication tower. Two access road alternatives are proposed and was assessed in this study.	
<b>Potential Impact</b>	Destruct, destroy or permanently close-in fossils at or below the ground surface that are then no longer available for research	
<b>Activity/risk source</b>	<ul style="list-style-type: none"> <li>Activities associated with the construction of the project. The infrastructure associated with the switching station will include a new access road and a communication tower</li> </ul>	
<b>Mitigation: Target/Objective</b>	Protection of identified fossils uncovered during the construction phase.	
<b>Mitigation: Action/control</b>	<b>Responsibility</b>	<b>Timeframe</b>
	ECO	Construction phase

## 11 FINDINGS AND RECOMMENDATIONS

The proposed actual footprint is primarily underlain by the Vryheid Formation of the Permian Ecca Group while the study area cuts into a small part of the Damwal Formation (Rooiberg Group, Bushveld Complex). The project site is underlain by Rashoop Granophyre Suite (Bushveld Complex). The Damwal Formation and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

The Vryheid Formation (Ecca Group) is world renowned for the occurrence of coal beds formed by the accumulation of plant material. This Formation is also characterised by its trace fossil assemblages of the non-marine *Mermia* Ichnofacies, fish and small crustaceans as well as insect fossils track ways. The unique *Mesosaurus* reptile may also be present. Trace fossils, low in diversity, are abundantly found. Rare insects, possible conchostracans, non-marine bivalves and fish scales are also present. This Formation has a very high Palaeontological sensitivity. The Damwal Formation (Rooiberg Group) and Rashoop Granophyre Suite of the Bushveld Complex consist of igneous rock which is unfossiliferous and has a very low palaeontological sensitivity.

During a field survey of the development footprint, no fossiliferous outcrops were found. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the project and associated infrastructure will be of a low significance in palaeontological terms. As the geology of the road alternatives are the same the



impacts are expected to be the same and there is thus no preferred access road alternative. It is therefore considered that the construction and operation Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province as well as the both road alternatives is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Therefore, the construction and operation of the project (and its associated impacts) may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

Irrespective of the uncommon occurrence of fossils a solitary fossil may be of scientific value as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the development area. In the event that fossil remains are uncovered during any phase of construction, either on the surface or unearthed by new excavations and vegetation clearance, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (if possible *in situ*) and the ECO must report to SAHRA so that appropriate mitigation (e.g. recording, collection) can be carry out by a professional paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies proposed by SAHRA.

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### **13 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR**

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty three years. She has been conducting Palaeontological Impact Assessments since 2014.

### **14 DECLARATION OF INDEPENDENCE**

I Elize Butler, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.