APPENDIX F8: Palaeontology Desktop Assessment

BANZAI ENVIRONMENTAL

PALAEONTOLOGICAL DESKTOP ASSESSMENT

MOSSDUSTRIA EXPANSION AND DEVELOPMENT OF A RACEWAY, IN MOSSEL BAY, IN THE WESTERN CAPE PROVINCE

2023

COMPILED FOR: Nemai

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 take into account, 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.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE: 

The 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**: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)*

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the 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 vita	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	-
(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 8	-
(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 4 Approach and Methodology	-
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated	Section 1 & 9	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
structures and infrastructure, inclusive of a site plan identifying site alternatives;		
(g) An identification of any areas to be avoided, including buffers	Section 1 & 9	
(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 4.1 – Assumptions and Limitations	-
(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	Sections 1 and 9	
(k) Any mitigation measures for inclusion in the EMPr	Section 1 and 9	
(l) Any conditions for inclusion in the environmental authorisation	Section 1 and 9	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 9	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 &9	
(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 9	-
(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

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
		process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments regarding heritage resources that require input from a specialist have been raised.
(q) Any other information requested by the competent authority.	N/A	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

Banzai Environmental was appointed by GIBB Environmental to conduct the Palaeontological Desktop Assessment (PDA) to assess the proposed Mossdustria expansion and raceway development in Mossel Bay, Western Cape Province. In accordance with the National Environmental Management, 1998 (Act No. 107 of 1998) (NEMA) and to comply with the National Heritage Resources Act, 1999 (Act No. 25 of 1999, section 38) (NHRA), it is necessary to confirm if fossil material could potentially be present in the planned development area and to evaluate the potential impact of the proposed development on the Palaeontological Heritage of the area.

The proposed Mossdustria development area in Mossel Bay is underlain by the Table Mountain Group (Cape Supergroup) represented by the Peninsula and Tchando Formations as well as the Rietvlei Formation (Nardouw Subgroup). The PalaeoMap of the South African Heritage Resources Information System, (SAHRIS) indicates that the Palaeontological Sensitivity of the Peninsula Formation is High, while that of the Tchando Formation is Low and the Rietvlei Formation has a Moderate Palaeontological Sensitivity (Almond and Pether, 2009; Almond et al., 2013). Palaeontological Sensitivity generated by the DFFE National Environmental Web-Based Screening (Department of Forestry, Fisheries and the Environment) indicates that the study area has a High Palaeontological Sensitivity.

No site investigation was conducted for the project but desktop research indicates that the Palaeontological Sensitivity of the area is LowIt is thus considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. It is thus concluded that the fossil heritage of scientific and conservation value in the study area is relatively scarce. A High Palaeontological Significance has been assigned to the construction phase of the development before mitigation, with a Low Significance after mitigation. The construction phase will be the only phase that could impact palaeontological heritage, and no significant impacts are anticipated during the operational or decommissioning phases. The No-Go alternative, which involves maintaining the status quo, will have a neutral impact on the palaeontological heritage of the development. The cumulative impacts of the project are considered Low prior to mitigation and Very Low after mitigation, both of which fall within acceptable limits for the project. Therefore, it is concluded that the proposed development will not result in any significant damage to the palaeontological resources in the area.

As the development footprint is not considered sensitive in terms of palaeontological resources, the construction of the development may proceed in its entirety. No further palaeontological studies, ground-truthing, or specialist mitigation are necessary unless new fossil discoveries are made during construction.

The construction of the development may therefore be authorised as the development footprint is not considered sensitive in terms of palaeontological resources. 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 any fossil material is exposed during operations, the attached Chance Find Protocol must be implemented without delay. Fossil discoveries must be protected in situ and reported promptly to the Heritage Western Cape (Contact: 3rd Floor, Protea Assurance Building, 142 Longmarket Street, Cape Town; Tel: +27 (0)21 483 9598; Fax: +27 (0)21 483 9845; Web: www.hwc.org.za). Mitigation measures, including recording and collection by a professional palaeontologist, may be required. Prior to the collection of any fossil material, the appointed specialist must obtain a fossil collection permit from SAHRA. All collected material must be curated in an approved repository (such as a museum or university), and all fieldwork and reporting must adhere to the minimum standards for palaeontological impact assessments as set out by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for Mossdustria development in the Western Cape Province.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Planning Stage	No Impact		No Impact		No Impact
Construction Stage:	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	34	Negative Medium impact	17	Negative Low impact
Operational Phase:	No Impact		No Impact		No Impact
Decommissioning Phase	No Impact		No Impact		No Impact

It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area. Thus, the construction of the development may be authorised in its whole extent.

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GLOSSARY OF TERMS

Fossil

A fossil is the preserved remains or traces of an organism that lived in the distant past, typically millions of years ago. Fossils may include mineralized skeletal structures, shells, or other durable components of ancient flora and fauna, as well as impressions, moulds, and casts formed in sedimentary rock as a result of the decomposition of the organism's remains. These preserved remnants offer significant insights into the evolutionary processes and biodiversity of past species, thereby enabling scientists to investigate and comprehend the patterns of evolution and the diversity of life forms that existed in prehistoric ecosystems.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act No 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance.
- places to which oral traditions are attached or which are associated with living heritage.
- historical settlements and townscapes.
- landscapes and natural features of cultural significance.
- geological sites of scientific or cultural importance.
- archaeological and palaeontological sites.
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past (other than fossil fuels or fossiliferous rock intended for industrial use) and any site which comprises of fossilised remains or traces of past life.

LIST OF ABBREVIATIONS

BA	Basic Assessment
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
CA	National Competent Authority
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
HIA	Heritage Impact Assessment
Ma	Millions of years ago
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PIA	Palaeontological Impact Assessment
PSSA	Palaeontological Society of South Africa
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
S&EIA	Scoping & Environmental Impact Assessment
ToR	Terms of Reference

1 INTRODUCTION

Mossel Bay Local Municipality (MBLM) plans to apply for Environmental Authorisation (EA) for the proposed extension of Mossdustria (+/- 12 ha), the establishment of a motorsport arena (+/- 38 ha), development of a solar photovoltaic (PV) facility (+/- 22 ha), and a conservation area (+/- 15 ha). GIBB Environmental has been appointed to conduct the Scoping and Environmental Impact Reporting to obtain Environmental Authorisation (EA) for the proposed development on the Remainder of Portion 8 of Farm Rietvalley 22, Mossel Bay, Western Cape Province. Banzai Environmental has, in turn, been appointed to conduct the Palaeontological Desktop Assessment for the proposed development (Figure 1-2).

The proposed project comprises of an industrial development with associated infrastructure, an alternative energy production area, a conservation area, a business area and a motorsport arena that includes training facilities, fuel storage, workshops, pavilions, tracks, parking, ablution facilities and associated infrastructure (Figure 3).

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The current study was conducted by Mrs. Elize Butler, who has completed approximately 900 palaeontological impact assessments for development projects across various provinces in South Africa, including Free State, KwaZulu-Natal, Eastern Cape, Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. Mrs. Butler holds an MSc (cum laude) in Zoology, with a specialization in Palaeontology, from the University of the Free State. With over 30 years of experience in the field, she is highly skilled in locating, collecting, and preserving fossils. She began conducting Palaeontological Impact Assessments (PIAs) in 2014 and has been a member of the Palaeontological Society of South Africa (PSSA) since 2006.

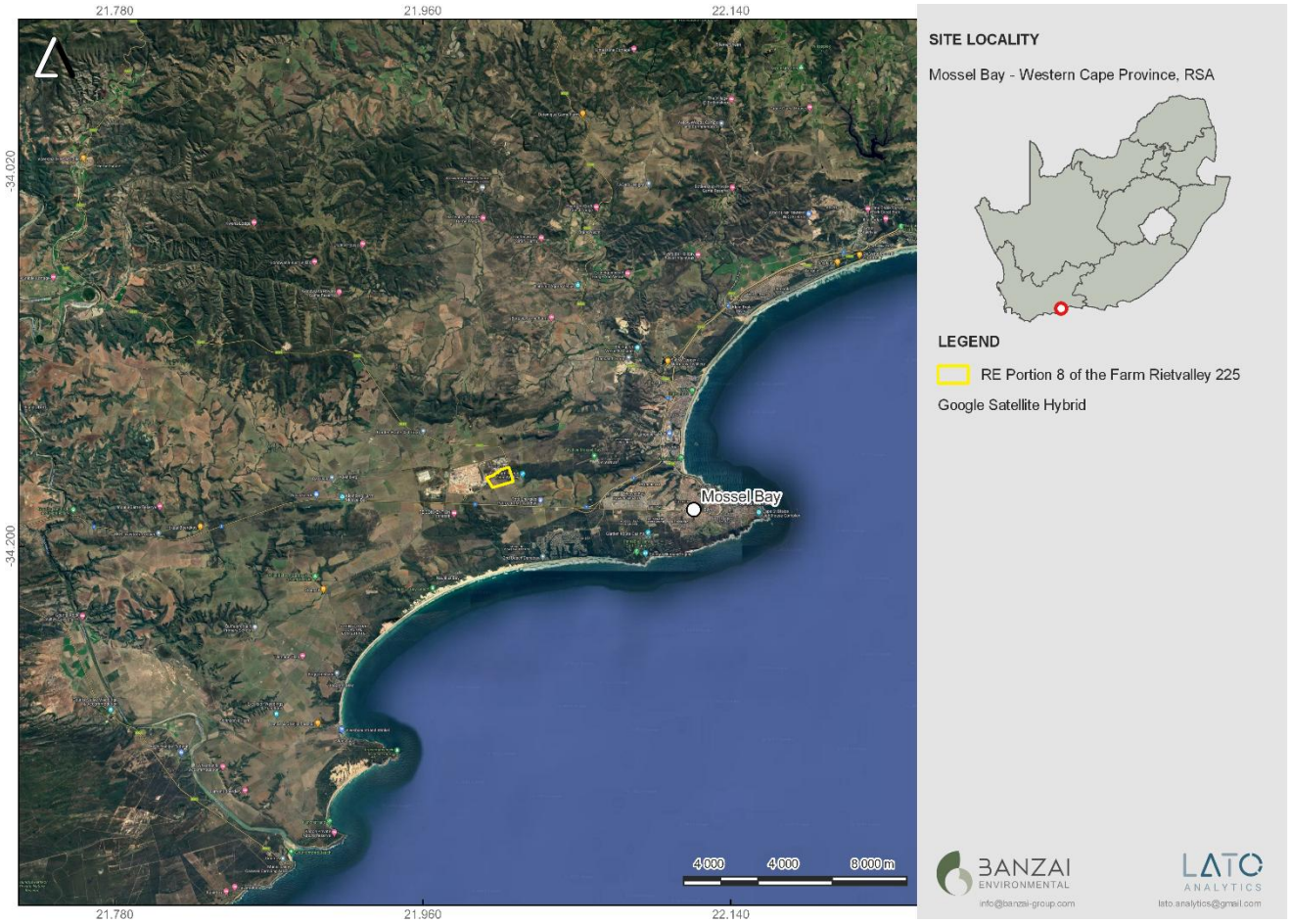


Figure 1: *Regional locality of the proposed expansion of the Mossdustria residential and raceway development located on the RE of Portion 8 of the farm Rietvlei in Mossel Bay, Eastern Cape Province.*

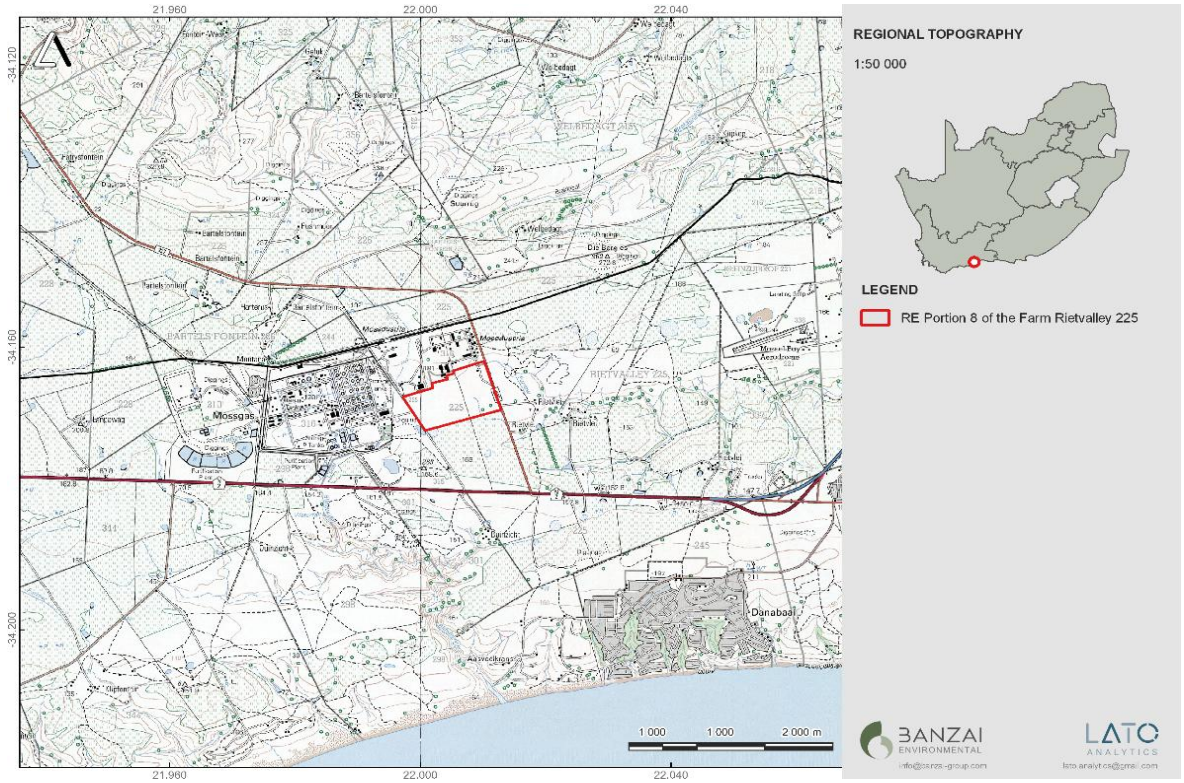


Figure 3: *Regional topography of the proposed study area in Mossel Bay, Eastern Cape Province.*

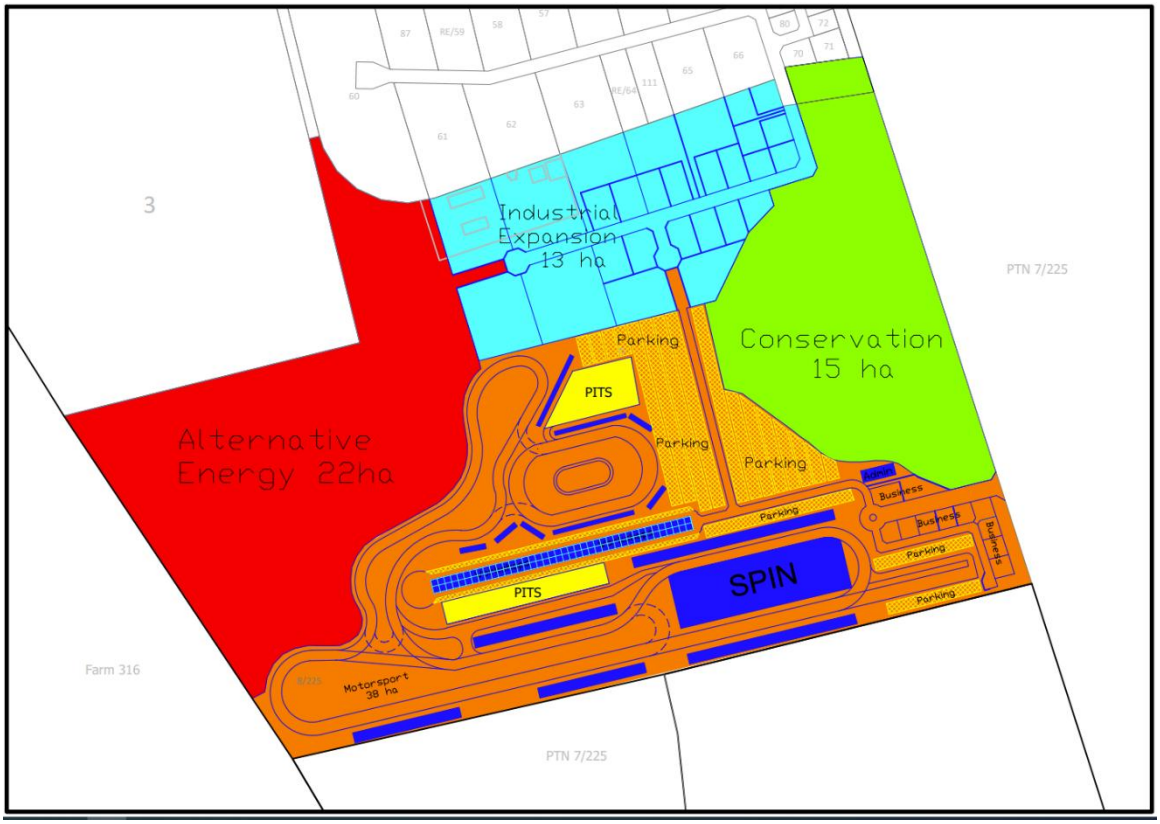


Figure 2: *Proposed layout of the development*

3 LEGISLATION

Cultural and palaeontological heritage in South Africa is safeguarded through a robust legal framework that ensures the protection, management, and sustainable use of heritage resources. The National Heritage Resources Act (Act No. 25 of 1999) (NHRA) forms the cornerstone of this system and defines heritage resources as part of the national estate, encompassing cultural, historical, archaeological, palaeontological, and geological materials of significance. According to Section 3 of the NHRA, 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."

The NHRA is administered by the South African Heritage Resources Agency (SAHRA) at the national level and Provincial Heritage Resources Authorities (PHRAs) at the provincial level. This three-tier system of heritage management mirrors South Africa's cooperative governance structure and promotes the identification, protection, and conservation of heritage resources for the benefit of present and future generations.

3.1 Legislative Context and Associated Frameworks

The identification and assessment of cultural and fossil heritage in South Africa are governed by a combination of interrelated legislation, including:

- National Environmental Management Act (NEMA) 107 of 1998
- National Heritage Resources Act (NHRA) 25 of 1999
- NEMA Protocols, particularly the *General requirements for site sensitivity verification and minimum report content requirements* (Government Notice 320 of 20 March 2020)
- Environmental Impact Assessment (EIA) Regulations, 2014 (GN R982, Government Gazette 38282 of 4 December 2014), covering:
    - Basic Assessment – Regulations 19 & 20
    - EIA Process – Regulation 23
    - Scoping Report – Regulation 21
    - EMPr – Regulations 19 & 23

Section 23(2)(b) of NEMA states that integrated environmental management must "identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions, and cultural heritage." This embeds heritage management within the broader environmental assessment process and promotes responsible, sustainable development.

3.2 The National Heritage Resources Act

The NHRA provides the legislative framework for managing South Africa's heritage resources. Sections 34 to 36 protect historical buildings, archaeological and palaeontological resources, and burial grounds, while Section 38 governs heritage resource management in relation to development. Palaeontological heritage is non-renewable and enjoys specific protection under Section 35, which prohibits the disturbance, destruction, or removal of fossils without a valid permit issued by SAHRA or the relevant PHRA. Fossil material must be collected and curated in an accredited institution, and all work must comply with SAHRA's minimum standards. These provisions ensure the responsible conservation of fossil heritage for scientific and educational benefit.

3.3 Section 38: Heritage Impact Assessments (HIA)

Section 38 mandates that certain categories of development or land-use change require a Heritage Impact Assessment (HIA) to identify and mitigate potential impacts on heritage resources.
An HIA is required for:

- Construction of a road, wall, power line, pipeline, canal, or other linear development exceeding 300 m;
- Construction of a bridge or similar structure exceeding 50 m;
- Developments changing a site's character, including those exceeding 5 000 m², involving three or more erven, or rezoning exceeding 10 000 m².

Once triggered, SAHRA or the relevant PHRA must be notified, and a heritage assessment, including archaeological or palaeontological studies, may be required. A complete HIA should:

- Identify and describe heritage resources in the affected area;
- Assess their significance and potential impacts;
- Consider feasible alternatives; and
- Recommend appropriate mitigation and management measures.

This ensures that heritage resources are evaluated and safeguarded through informed planning and mitigation.

3.4 Integration with Environmental Assessment

Section 38(8) of the NHRA allows the heritage assessment process to be integrated with the National Environmental Management Act (NEMA) when both Acts are triggered. This integrated process prevents duplication and ensures that heritage management is fully incorporated into environmental authorisation.
For palaeontological assessments, this means that the Palaeontological Impact Assessment (PIA) can form part of the HIA within the broader EIA framework, promoting early identification and protection of fossil heritage during development planning.

3.5 Conclusion

The National Heritage Resources Act (Act No. 25 of 1999) remains the foundation of heritage protection in South Africa. Through Section 35 on archaeological and palaeontological resources and Section 38 on heritage impact assessments, the Act ensures that development proceeds in harmony with the conservation of the country's irreplaceable natural and cultural heritage.

Together with the National Environmental Management Act (Act No. 107 of 1998) and its associated regulations, the NHRA provides a coherent, legally robust framework for heritage resource management. Compliance with these legislative requirements ensures that palaeontological resources are identified, documented, and preserved in accordance with national standards, supporting both scientific knowledge and sustainable development.

4 METHODS AND TERMS OF REFERENCE

This Palaeontological Desktop Assessment forms part of the Heritage Impact Assessment Report. According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the purpose of the PIA is: 1) to identify the palaeontological importance of the rock formations in the footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) to clarify the impact on fossil heritage; and 4) to suggest how the developer might protect and lessen possible damage to fossil heritage.

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

All possible information was consulted to compile a scoping specialist input report, which included the following: Provisional DFFE Screening Tool, SAHRIS Palaeosensitivity map, Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical and geological maps as well as scientific articles of specimens from the development area and Assemblage Zones. A field-based assessment is necessary when the development footprint has a Very High to High paleontological sensitivity. The desktop and the field survey of the exposed rock determine the impact significance of the planned development, and 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 destroy or permanently seal in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

During a site investigation, the palaeontologist surveys the development and tries to determine the density and diversity of fossils in the development area. The palaeontological heritage field research concentrated on analysing certain potentially fossil-rich locations, notably those with good Beaufort

Group mudrock exposure. Rock exposures that are investigated usually contain a large portion of the stratigraphic unit, can be accessed easily and comprise of unweathered (fresh) exposed rock. These exposures may be natural (rocky outcrops in streams or riverbanks, cliffs, dongas) but could also be artificial (quarries, open building excavations, and even railway and road cuttings). It is common practice for palaeontologists to log well-preserved fossils (GPS, and stratigraphic data) during field assessment studies.

Mitigation usually precedes construction or may occur during construction when potentially fossiliferous bedrock is exposed. 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 SAHRA approved fossil repository. When mitigation is applied correctly, a positive impact is possible as knowledge of local palaeontological heritage may be increased.

When a site investigation is conducted, the fossil potential of the study area is determined by physically investigating bedrock outcrops to determine the lithology and fossil content of the outcrops. Fossils occurring at the surface are very unpredictable, and a representative sample size of the area has been investigated. However, it is important to note that the absence of fossils in a development footprint does not necessarily mean that palaeontological significant material is not present on site (on or beneath ground surface).

The terms of reference of a PIA are as follows:

General Requirements:

- Conduct field surveys and compile a specialist study in adherence to:
    a. the gazetted Environmental Assessment Protocols of the 2014 NEMA EIA Regulations (as amended), where applicable (i.e. Part A - General Protocol for the Site Sensitivity Verification and Minimum Report Content Requirements where a Specialist Assessment is required but no specific Environmental Theme Protocol has been prescribed (GG 43110 / GNR 320, 20 March 2020));
    b. Appendix 6 of the 2014 NEMA EIA Regulations (as amended) (GG 40772 / GNR 326, 07 April 2017);
    c. National Heritage Resources Act (Act 25 of 1999), as applicable, and
    d. any additional relevant legislation and guidelines that may be deemed necessary.
- 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/kmls) 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 are impacts that 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).

4.1 Assumptions and Limitations

The geology of the area is primarily represented in geological maps, which, along with the accompanying sheet explanations, were not designed to address palaeontological heritage specifically. Many remote areas of South Africa have not been explored by palaeontologists, and in such cases, available data often relies solely on aerial imagery. Locality and geological information stored in museums and university databases is frequently outdated, and past data is not always thoroughly documented.

To supplement the available information, comparable Assemblage Zones from other regions are often referenced to help determine the potential presence of fossils in areas that have not been previously surveyed. When conducting desktop studies, it is typically assumed that fossils are present within the geological formations and Assemblage Zones identified. However, field assessments are essential to refine the findings from desktop evaluations and to provide a more accurate understanding of the fossil potential in the area. Thus, a site investigation was conducted for this study.

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Mossdustria development in Mossel Bay is depicted on the 1: 250 000 Oudtshoorn 3322 (1979) and 3420 Riversdale (1993) Geological Map (Council for Geosciences, Pretoria) (Figure 4, Table 2-3). These maps indicates that the proposed development is underlain by

the Table Mountain Group (Cape Supergroup) represented by the Peninsula (Op) and Tchando (St) Formations as well as the Rietvlei (Dr) Formation (Nardouw Subgroup). The PalaeoMap of the South African Heritage Resources Information System, (SAHRIS) indicates that the Palaeontological Sensitivity of the Peninsula Formation is High, while that of the Tchando Formation is Low and the Rietvlei Formation has a Moderate Palaeontological Sensitivity (Figure 5, Table 4; Almond and Pether, 2009; Almond et al., 2013). Palaeontological Sensitivity generated by the DFFE National Environmental Web-Based Screening (Department of Forestry, Fisheries and the Environment) indicates that the study area has a High Palaeontological Sensitivity (Figure 6).

The Cape Supergroup represents about 170 million years of earth history (Early Ordovician (~500 Ma) to the Early Carboniferous (~330 Ma) (Thamm and Johnson, 2006). The sediments of the Cape Supergroup were deposited along the northern edge of the semi-enclosed Agulhas Sea. The latter opened in reaction to early rifting between Africa, South America, and Antarctica. Today, this Supergroup forms the southern mountain ranges of the Western and Eastern Provinces.
The sedimentary rocks of the siliciclastic Cape Supergroup (up to 10 km thick) are divided into three Groups namely (youngest at the top to the oldest at the bottom) Witteberg, Bokkeveld, and the Table Mountain Group.

The Nardouw Subgroup of the Table Mountain Group is represented in the development by the Rietvlei Formation (Figure 4). According to the Palaeotechnical Report of the Northern Cape Province this formation contains "braided fluvial pebbly sandstones with rare mudrocks in thin, shallow marine- /estuarine influenced parts of succession". Trace fossil assemblages is present in the more mudrock-rich part of succession consists of *Skolithos* "pipe rock", horizontal burrows as well as trilobite burrows).

The Table Mountain Group of the Cape Supergroup is divided in the 5 Formations that include the Cederberg, Pakhuis, Peninsula, Graafwater and Piekenierskloof Formations (Figure 5-6). In the development area the Table Mountain Group is represented by the main unit of the Cape Supergroup namely the Peninsula Formation. This Formation is characterized by quartz arenite and minor shales and conglomerates.

The Peninsula Formation is about 2000 m thick in the west (Rust, 1967) and about 2700 m thick in the east (Johnson, 1976) and thins quickly north of the trough axis. Broquet (1990) proposed that the Peninsula Formation is subdivided in the Leeukop and Platteklip Members in the Cape Peninsula. These Members are divided by a meter-thick clast-supported conglomerate comprising of a small population of wind-facetted ventifacts.

Palaeontologically, the Cape Supergroup is important because of the diverse trace/ichno fossils of the lower Table Mountain Group, while the shales of the Table Mountain Group contain invertebrate fossils (Table 5).

The Peninsula Formation is known for its nearshore fluvial and/ estuarine as well as shallow marine trace fossils (mainly form the Western Cape). Authors contributing to these findings are Rust 1967, Potgieter & Oelofsen 1983, Broquet 1990, 1992, Almond 1998a-b, Braddy & Almond 1999, Thamm & Johnson 2006. These articles mention arthropod trackways, vertical dwelling, and horizontal burrows, as well as trilobite resting and feeding burrows.

The Pakhuis Formation comprise of pebbly sandstone, diamictite, mudrock with dropstones and varved mudrock. These sediments host facetted, polished and striated clasts and is restricted to the western portion of the basin. A low diversity of brachiopod dominated shelly faunas is known from this formation.

The Cedarberg Formation contain dark shale at its base (Soom Shale Member), coarsening upward into siltstone (Disa Siltstone Member). This formation is about 50-120m thick and commonly contain marine invertebrate fossils including brachiopods, conodonts, chitinozoans eurypterids, trilobites, and several trace fossils (Cocks *et al.*, 1969; Cocks and Fortey, 1986; Aldridge *et al.*, 1994) (Fig. 6). The Soom Shale also contain spore tetrads of land plants (Gray *et al.*, 1986).

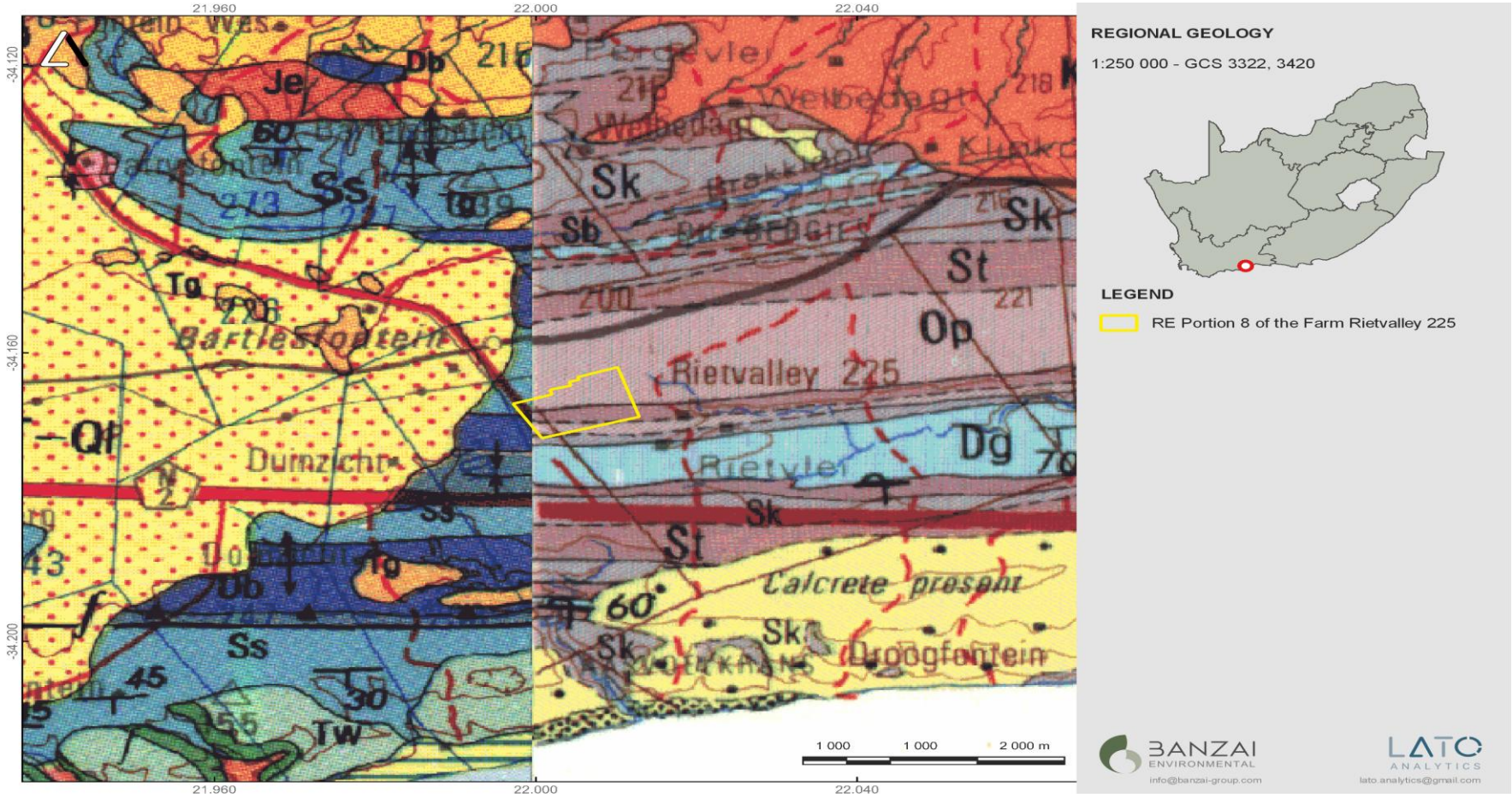


***Figure 4**: Extract of the 1:250 000 Oudtshoorn 3322 (1979) and 3420 Riversdale (1993) Geological Map (Council for Geosciences, Pretoria) indicating the geology of the proposed Mossdustria development in Mossel Bay, Eastern Cape Province.*

***Table 2**:Legend of the Oudtshoorn 3322 (1979) Geological Map (Council for Geosciences, Pretoria) indicating that the study area is underlain by the Table Mountain Group (Cape Supergroup).*

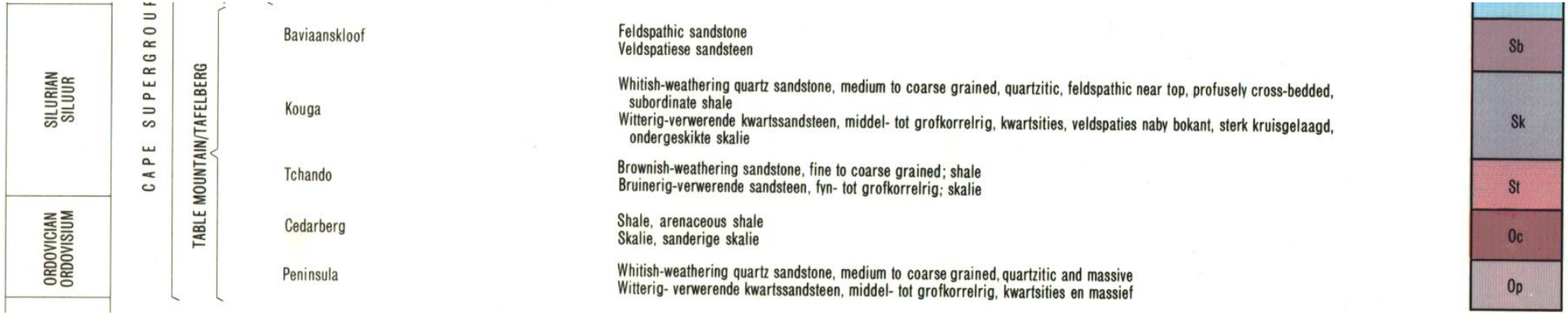
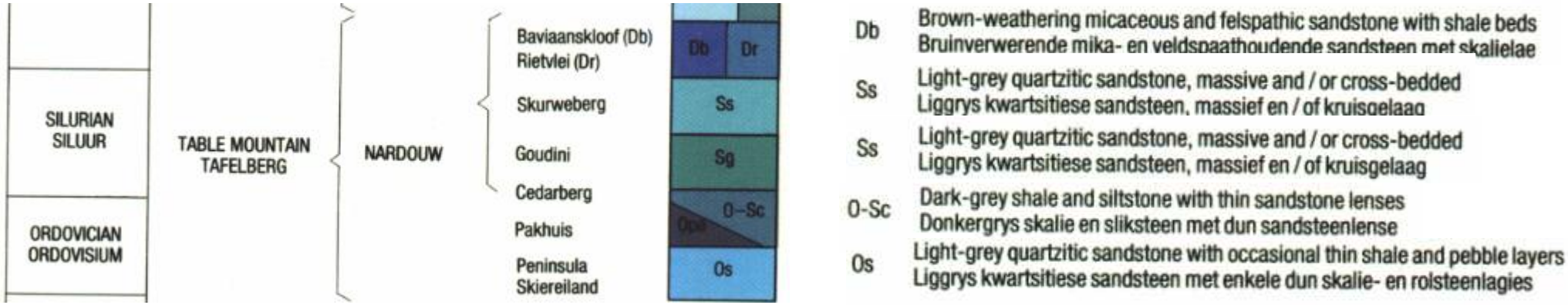


***Table 3**: Legend of the 3420 Riversdale (1993) Geological Map (Council for Geosciences, Pretoria) indicating that the study area is underlain by the Table Mountain Group (Cape Supergroup).*



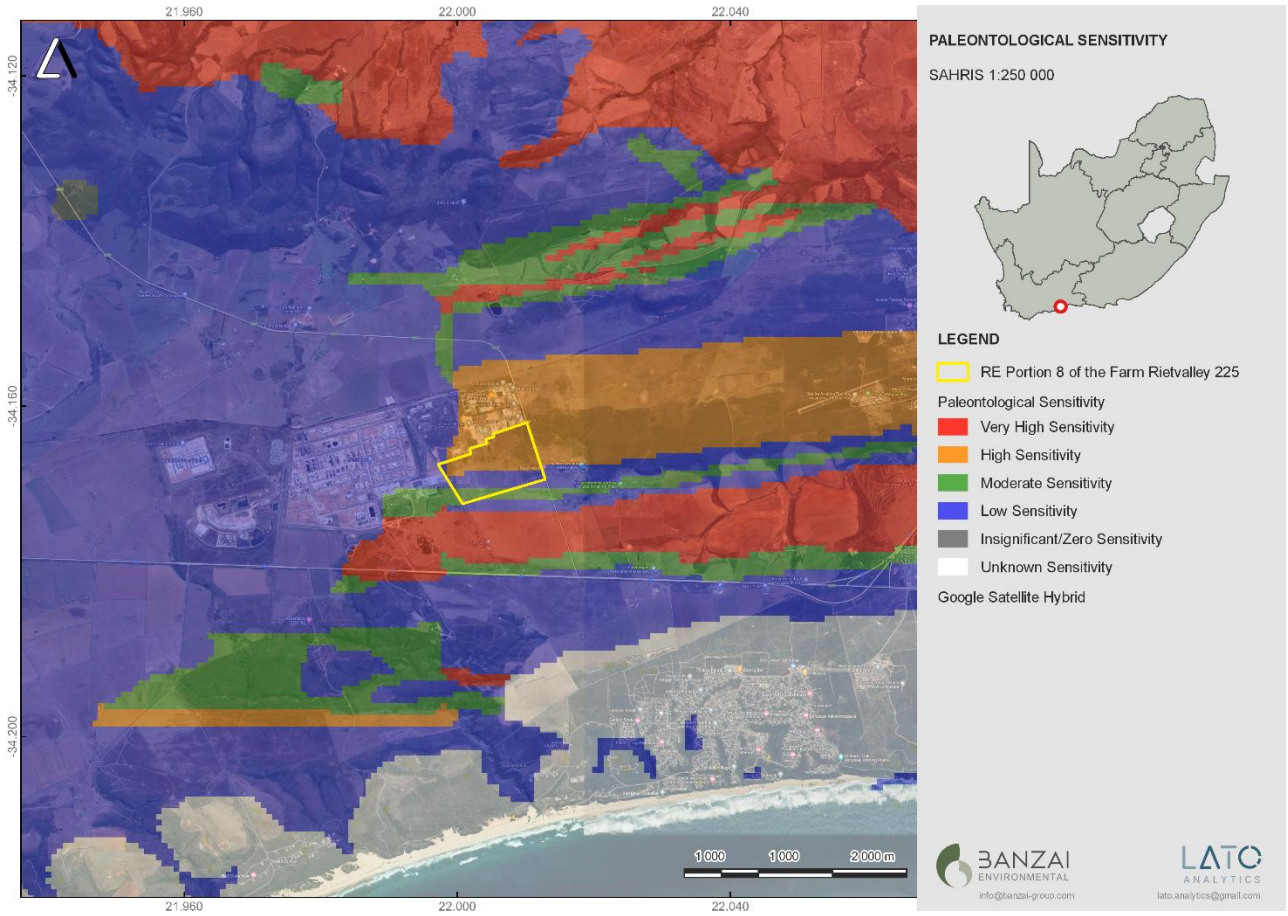


***Figure 5**: Extract of the SAHRIS Palaeosensitivity Map indicates that the study area is underlain by sediments with a High, Moderate and Low Palaeontological Sensitivity.*

Table 4: *Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website).*		
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.

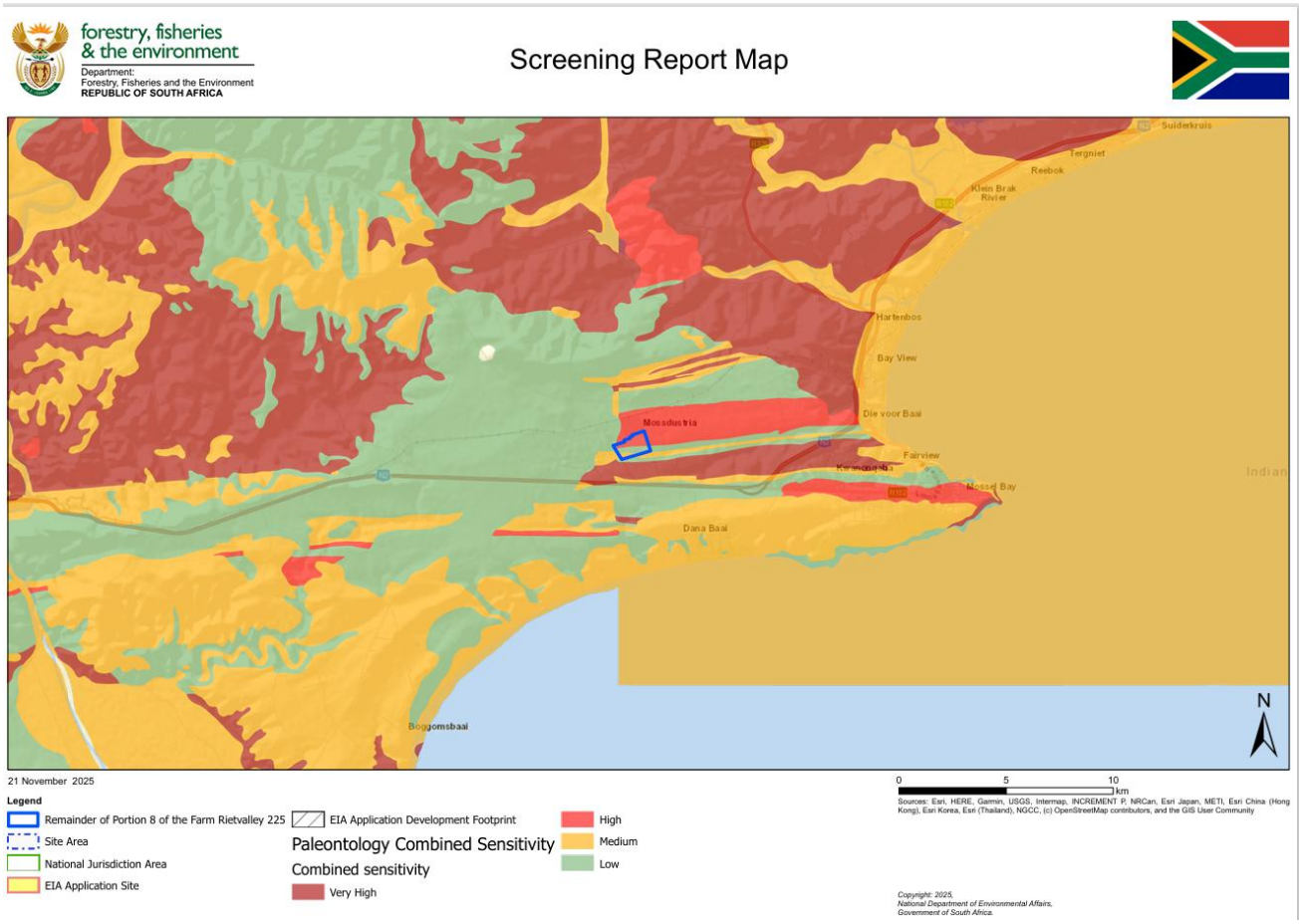


***Figure 6**: Palaeontological Sensitivity of the proposed study area by the National Environmental Web-based Screening Tool indicates a High (red), Palaeontological Sensitivity.*

***Table 5**: Extract of the Palaeotechnical Report of the Northern Cape Province (Almond & Pether 2009).*

9. TABLE MOUNTAIN GROUP	**9f. Rietvlei Fm (Dr)** Early Devonian	**Nardouw Subgroup** Braided fluvial pebbly sandstones with rare mudrocks in thin, shallow marine- /estuarine-influenced parts of succession	Sparse marine / estuarine /?fluvial trace fossil assemblages (trilobite burrows, *Skolithos* "pipe rock", horizontal burrows) within more mudrock-rich part of succession	Low diversity, brachiopod-dominated shelly faunas recorded from eastern outcrop area (outside N. Cape)
	9e. Skurweberg Fm (Ss) Silurian			
	9d. Goudini Fm (Sg) Early Silurian			Limited outcrops in N. Cape
	9c. Cederberg Fm (Ow) Late Ordovician	Post-glacial mudrocks (**Soom Member**) grading up into shallow marine sandstones(**Disa Member**)	**Soom Member** with moderately diverse marine biota of various microfossils, "algae", soft-bodied and shelly invertebrates (eurypterids, trilobites, nautiloids, brachiopods *etc*), primitive jawless fish, some showing exceptional soft tissue preservation. **Disa Member** with low-diversity shelly invertebrate dominated by brachiopods, also rare molluscs, trilobites, shallow marine trace fossil assemblages	World-famous post-glacial Cederberg biota not recorded yet in N. Cape – but almost certainly only due to insufficient exposure.
	9b. Pakhuis Fm (Ow) Late Ordovician	Sandy and muddy glacial diamictites (tillites)	V. rare interglacial / post-glacial trace fossils	Global mass extinctions correlated with two short end Ordovician glaciations on Gondwana
	9a. Peninsula Fm (Op) Early – Late Ordovician	Fluvial sandstones, quartzites, subordinate mudrocks within thin marine / estuarine intercalations	Sparse shallow marine / coastal /estuarine to freshwater trace fossils, including eurypterid trackways, trilobite burrows	N. Cape outcrop v. limited (Bokkeveld Plateau)

Table 6: Stratigraphy, lithology and palaeoenvironments of the Table Mountain Group.

Approximate maximum thicknesses (m) are indicated in brackets. "Shallow marine" represents high-energy coastal environments (e.g., beach, barrier, shoreface, etc.) (Figure taken from Thamm and Johnson, 2006).

AGE	WEST OF ~21°E		EAST OF ~21°E		LITHOLOGY	PALAEOENVIRONMENTS
		FORMATION		FORMATION		
DEV.	NARDOUW SUBGROUP	Rietvlei (200)	NARDOUW SUBGROUP	Baviaanskloof (200)	Sandstone (+ shale in east)	Shallow marine (+ offshore shelf in east)
SILURIAN		Skurweberg (300)		Skurweberg (400)	Sandstone (thick-bedded)	Fluvial braid-plain, shallow marine
		Goudini (200)		Goudini (300)	Sandstone (red-brown)	Shallow marine, fluvial braid-plain
ORDOVICIAN		Cedarberg (120)		Cedarberg (50)	Shale, siltstone	Offshore shelf
		Pakhuis (80)		-	Diamictite, sandstone	Glacial
		Peninsula (2000)		Peninsula (2700)	Sandstone	Fluvial braid-plain, shallow marine
		Graafwater (430)		Sardinia Bay (900?)	Sandstone, siltstone, shale	Distal fluvial, tidal flat, shallow marine
		Piekenierskloof (900)			Sandstone, conglomerate	Fluvial braid-plain

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Mossdustria development is located on the Remainder of Portion 8 of Farm Rietvalley 225, Mossel Bay, Western Cape Province (Figure 1-3).

7 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);
- Google Earth© satellite imagery
- A Google Earth map with polygons of the proposed development was obtained from Gibb Environmental;
- 1:250 000 Oudtshoorn 3322 (1979) and 3420 Riversdale (1993) Geological Map (Council for Geosciences, Pretoria);
- Palaeotechnical report of the Northern Cape Province (Almond & Pether, 2009); and
- SAHRIS PalaeoMap.
- Palaeosensitivity map on SAHRIS (South African Heritage Resources Information System) website
- Department of Forestry, Fisheries and the Environment Screening tool report

8 IMPACT ASSESSMENT METHODOLOGY

Impact assessment must take account of the nature, scale, and duration of impacts on the environment, whether such impacts are positive or negative. Each impact is also assessed according to the following project phases:

- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

***Table 7**: The rating system*

NATURE
The Nature of the Impact is the possible destruction of fossil heritage
GEOGRAPHICAL EXTENT
This is defined as the area over which the impact will be experienced.

1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.

2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible, and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.

3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects

SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity = X. The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive

Table 8: Summary of Impact Tables

PALAEONTOLOGICAL								
NATURE	LOSS OF FOSSIL HERITAGE BY DESTRUCTION, MOVEMENT OR SEALING IN OF FOSSIL HERITAGE IN OR BELOW THE EARTH'S SURFACE SITE(S):							
DEVELOPMENT PHASE	DEVELOPMENT IMPACT			IMPACT RATING		RECOMMENDED MITIGATION	IS IMPACT ACCEPTABLE?	
	CRITERIA	*BM	**AM	BEFORE MITIGATION	AFTER MITIGATION		*BM	**AM
PLANNING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					

	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					
CONSTRUCTION PHASE	Extent	1	1	Negative low impact	Negative low impact	NONE	NO	YES
	Probability	2	2					
	Reversibility	4	4					
	Irreplaceability	4	4					
	Duration	4	4					
	Cumulative Effect	2	2					
	Magnitude	2	1					
	Impact Significance	34	17					
OPERATIONAL PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					
DECOMMISSIONING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					

8.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a Low probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

9 FINDINGS AND RECOMMENDATIONS

The proposed Mossdustria development area in Mossel Bay is underlain by the Table Mountain Group (Cape Supergroup) represented by the Peninsula and Tchando Formations as well as the Rietvlei Formation (Nardouw Subgroup). The PalaeoMap of the South African Heritage Resources Information System, (SAHRIS) indicates that the Palaeontological Sensitivity of the Peninsula Formation is High, while that of the Tchando Formation is Low and the Rietvlei Formation has a Moderate Palaeontological Sensitivity (Almond and Pether, 2009; Almond et al., 2013). Palaeontological Sensitivity generated by the DFFE National Environmental Web-Based Screening (Department of Forestry, Fisheries and the Environment) indicates that the study area has a Very High Palaeontological Sensitivity.

No site investigation was conducted for the project but desktop research indicates that the Palaeontological Sensitivity of the area is LowIt is thus considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. It is thus concluded that the fossil heritage of scientific and conservation value in the study area is relatively scarce. A High Palaeontological Significance has been assigned to the construction phase of the development before mitigation, with a Low Significance after mitigation. The construction phase will be the only phase that could impact palaeontological heritage, and no significant impacts are anticipated during the operational or decommissioning phases. The No-Go alternative, which involves maintaining the status quo, will have a neutral impact on the palaeontological heritage of the development. The cumulative impacts of the project are considered Low prior to mitigation and Very Low after mitigation, both of which fall within acceptable limits for the project. Therefore, it is concluded that the proposed development will not result in any significant damage to the palaeontological resources in the area.

As the development footprint is not considered sensitive in terms of palaeontological resources, the construction of the development may proceed in its entirety. No further palaeontological studies, ground-truthing, or specialist mitigation are necessary unless new fossil discoveries are made during construction.

The construction of the development may therefore be authorised as the development footprint is not considered sensitive in terms of palaeontological resources. 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 any fossil material is exposed during operations, the attached Chance Find Protocol must be implemented without delay. Fossil discoveries must be protected in situ and reported promptly to the Heritage Western Cape (Contact: 3rd Floor, Protea Assurance Building, 142 Longmarket Street, Cape Town; Tel: +27 (0)21 483 9598; Fax: +27 (0)21 483 9845; Web: www.hwc.org.za). Mitigation measures, including recording and collection by a professional palaeontologist, may be required. Prior to the collection of any fossil material, the appointed specialist must obtain a fossil collection permit from SAHRA. All collected material must be curated in an approved repository (such as a museum or university), and all fieldwork and reporting must adhere to the minimum standards for palaeontological impact assessments as set out by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for Mossdustria development in the Western Cape Province.

10 CHANCE FINDS PROTOCOL

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, protected by the NHRA, and is 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 construction activities accidentally uncover fossil material. It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to implement the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol not to compromise the conservation of fossil material.

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

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 ESO or site manager. The ESO 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 coordinates.

- 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 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 ESO (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 stabilised and covered by a plastic sheet or sandbags. 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 stabilised, the fossil may be collected with extreme care by the ESO (site manager). Fossil 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 authorisation, the developer may continue with the development in the affected area.
-

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Appendix A – Elize Butler CV

CURRICULUM VITAE

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	30 years in Palaeontology
EDUCATION:	University of the Orange Free State B.Sc Botany and Zoology, 1988
	University of the Orange Free State B. Sc (Hons) Zoology, 1991
	University of the Free State M. Sc. *Cum laude* (Zoology), 2009

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

EMPLOYMENT HISTORY

Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–2022
Banzai Environmental	2016 to present

Elize Butler has conducted approximately **850** Palaeontological Impact Assessments for developments in the Free State, KwaZulu-Natal, Eastern, Northern and Western 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. 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.

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently.