PALAEONTOLOGICAL FIELD ASSESSMENT OF THE PROPOSED SWAZILAND-MOZAMBIQUE BORDER PATROL ROAD AND MOZAMBIQUE BARRIER STRUCTURE

Prepared for:

Royal Haskoning DHV

Royal HaskoningDHV (Pty) Ltd trading as Royal HaskoningDHV

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06 October 2018

Prepared by:

BANZAI ENVIRONMENTAL (PTY) LTD

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable 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 favourable 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 realise that a false declaration is an offence 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: elizebutler002@gmail.com

SIGNATURE: 

The heritage impact assessment report has been compiled considering the NEMA Appendix 6 requirements for specialist reports as indicated in the table below.

Section in EIA Regulations 2014 (as amended)		**Clause**	**Section in Report**
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Page i of the report, Contact details and company
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Section 2 and Appendix 1
	(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;	N/A
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A

	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Section 7
	(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 5
	(g)	An indication of any areas to be avoided, including buffers;	N/A
	(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
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.1
	(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 or activities;	Section 9
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 9
	(l)	Any conditions for inclusion in the environmental authorization;	N/A
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	N/A
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Section 9

		(iA) regarding the acceptability of the proposed activity or activities; and	Section 9
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 9
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable. A public consultation process will be handled as part of the BA process.
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable. To date not comments regarding heritage resources that require input from a specialist have been raised
	(q)	Any other information requested by the authority.	Not applicable
	(2)	Where a government notice gazetted 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.	Not applicable

EXECUTIVE SUMMARY

Royal Haskoning DHV has appointed Banzai Environmental (Pty) Ltd to undertake a Palaeontological Impact Assessment (Phase 1) assessing the palaeontological impact of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. According to the National Heritage Resources Act (Act No 25 of 1999, Section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to evaluate the impact of the construction and operation of the barrier on the palaeontological resources.

The proposed project and base camp is underlain by various sedimentary rocks of which the **Quaternary** and the **Undifferentiated Karoo** has a **high Palaeontological sensitivity** and **the Zululand Group** which has a **very high palaeontological sensitivity**. The various intrusive rocks have an igneous origin and is thus unfossiliferous and has a zero palaeontological sensitivity. As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in February 2018 to assess the potential risk to palaeontological material in the proposed footprint of the development. A physical field-survey of the proposed development and camping site was conducted on foot and by vehicle and during this field survey, **no fossiliferous outcrops** were found in the development footprint although the possibility of finding fossils were high. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Although fossils are uncommon and only occur periodically 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.

The scarcity of fossil heritage at the proposed development footprint indicate that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

In the unlikely 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 should be protected (preferably *in*

situ) and the ECO must report to SAHRA so that suitable mitigation (collection and recording) 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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1 INTRODUCTION

The National Department of Public Works has appointed **Royal HaskoningDHV** to undertake the design of the border control structure and to obtain environmental authorisations for the proposed Mozambique barrier structure as well as the Swaziland-Mozambique Border Patrol Road.

The Mozambique **Border Barrier** extends in two sections from the eastern boundary of the iSimangaliso Wetland Park west to the eastern boundary of the Tembe Elephant Reserve (excluding Tembe Elephant Reserve) (Fig. 1). The second section is a narrow section between Tembe and the eastern Boundary of the Ndumo Game Reserve.

The **Border Patrol Infrastructure** consists of two main components – **a border patrol road and the international fence**, of which both will be upgraded. This component is the longest section and extends westward from Kosi Bay (Indian Ocean), west along the KZN-Mozambique border and the entire length of the Mpumalanga-Swaziland Border to the point in the Lowveld where the Mpumalanga Swaziland Border ends (a total length of approximately 529 km).

In sections of the 529 km the existing road will be upgraded to a 5.5 m wide gravel road, in other areas the road is absent and in these sections a new 5m-wide road will be developed. Due to topographic limitations, the road will not always follow the international border. Along certain areas of the border, where no road is planned, a 1.5 m wide footpath will be developed to permit border patrols.

The fence is generally in place along the entire border, although there are certain sections where no fence is proposed and instead beacons are proposed. These are in areas where the boundary is formed by a river or where the terrain is extremely mountainous. Two important examples is the KZN-Mozambique border within the Ndumo Game Reserve where the international border is the Usuthu River, and the highly mountainous section of the international border in the vicinity of the Songimvelo Game Reserve.

The **Royal HaskoningDHV** Route Determination team are still busy with the design, and a corridor of 50 m from the existing fence position will be assessed during the EIA process. This corridor ought to be sufficient to cater for any minor route realignments.

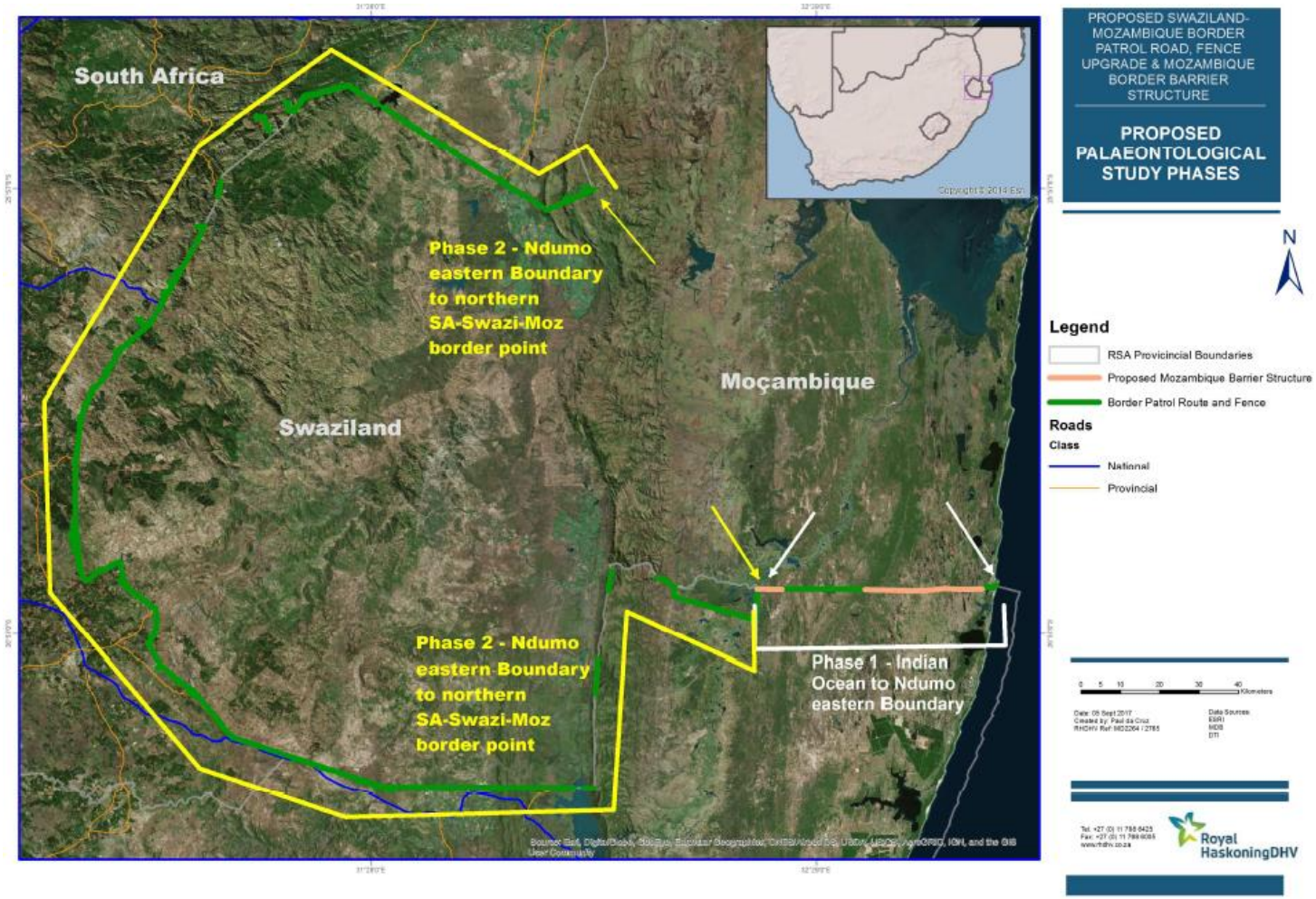

Figure 1: Locality map of the planned construction of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. (Map provided by Royal HaskoningDHV).

2 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-four years. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 12 years. She has been conducting PIAs since 2014.

3 LEGISLATION

3.1 NATIONAL HERITAGE RESOURCES ACT (25 OF 1999)

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

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. 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 as per section 35 of the NHRA.

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

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

- the re-zoning of a site exceeding 10 000 m² in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The objective of a Palaeontological Desktop 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 PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontologist compiles a desktop study the potentially fossiliferous rocks present within the development are established from 1:250 000 geological maps. The topography of the development is identified by 1:50 000 topography maps and Google Earth Images. Previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions which identify fossils found in close proximity to the development is used to identify the fossil heritage within each rock. The palaeontological status of each rock component in the development area is calculated and the possible impact of the development on fossil heritage is determined by a) the palaeontological importance of the rocks, b) the scale and type of development and c) the quantity of bedrock removed.

When it is determined that the development footprint has a moderate to high sensitivity a field-based assessment by a palaeontologist is necessary. By using the desktop and the field survey of the exposed rock the impact significance of the planned development is calculated and recommendations for any further studies or mitigation are made. Usually destructive impacts on palaeontological heritage only occur during the construction phase and the excavations will change 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 may precede construction or even better occur during construction when potentially fossiliferous bedrock is exposed. Mitigation comprises the collection and recording of fossils. It is

important that 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.

5 GEOLOGICAL AND PALAEONTOLOGICAL HERITAGE

The geology of the KZN- Mozambique Barrier Structure footprint is represented by the 1:250 000 2632 Kosi Bay Geological Map (Fig.2), while the Geology of the Swaziland-Mozambique Border Patrol Road is represented in the 3530 Barberton Geological Map (Fig.3). Geological Maps are provided by the Counsel of Geosciences. Discussions will be based on the above mentioned Geological Maps as well as the QGIS maps (Fig. 4-12). The abbreviations of the Geological maps (Fig 2-3) are explained in Table 1. The Geological history of this report will be divided into two (2) sections. One section will focus on the geological and palaeontological heritage of the development footprint in Kwazulu-Natal (1:250 000 2632 Kosi Bay Geological Map) and the other of Mpumalanga (1:250 000 3530 Barberton Geological Map).

Table 1: **Explanation of symbols for the geological map and Period. SG = Supergroup; Gr-Group; Fm = Formation. Palaeontological sensitivity is indicated by colour codes: Very High=-Red; High = orange. According to the SAHRIS PalaeoMap site visits is required for areas of High to Very High Palaeontological Sensitivity**

Symbol	Group/Formation	Lithology	Period
2632 Kosi Bay Geological Map Published in 1986 Sheet Explanation by Du Preez and Wolmarans 1986			
Qs	Quaternary	Yellowish redistribute sand	Cenozoic
Qbe	Berea Fm	Red dune cordon sand	Cenozoic
Qb	Bluff Fm	Calcareous sandstone	Cenozoic
Qm	Muzi Fm	Argillaceous sandstone	Cenozoic
Kmz	Zululand Gr Mzinene Fm	Marine siltstone with shelly and	Cenozoic

Symbol	Group/Formation	Lithology	Period
		concretionary horizons	
3530 Barberton Geological map Published in 1986 Sheet Explanation by F. Walraven and F.J. Hartzer. Youngest deposits first and oldest last.			
Q	**Quaternary**	**Superficial deposit, alluvium and scree**	**Cenozoic**
Jd	Karoo dolerite		Jurassic
Jl	Lebombo Gr Letaba Fm	Green, fine-grained mafic lava, locally porphyritic, amygdaloidal interlayered rhyolite especially near top	Jurassic
Jt	Tshokwane Granophyre	Intrusive rocks Pink, medium grained quartz feldspar granophyre, microgranite and syenite	Jurassic
Jj	Lebombo Gr Josini Fm	Red to light brown, fine grained rhyolitic lava, porphyritic rhyolite and tuf	Jurassic
P-T	**Undifferentiated Karoo**	**Mudrock and sandstone**	**Permian to Triassic**
Znm	Nelspruit Suite	Intrusive rocks	Swazian
Zu	Kaap Valley Granite		Swazian
Zm Zf	Barberton: Moodies Gr	Predominantly volcanic igneous	Swazian

Symbol	Group/Formation	Lithology	Period
Zgk Zt	Barberton: Fig Tree Gr Barberton: Onverwach Gr Geluk Subgroup Kromberg Fm Tjakastad Subgroup	rocks, plus some igneous intrusions, minor sediments such as banded iron formation, chert, quartzite, conglomerate, schists	

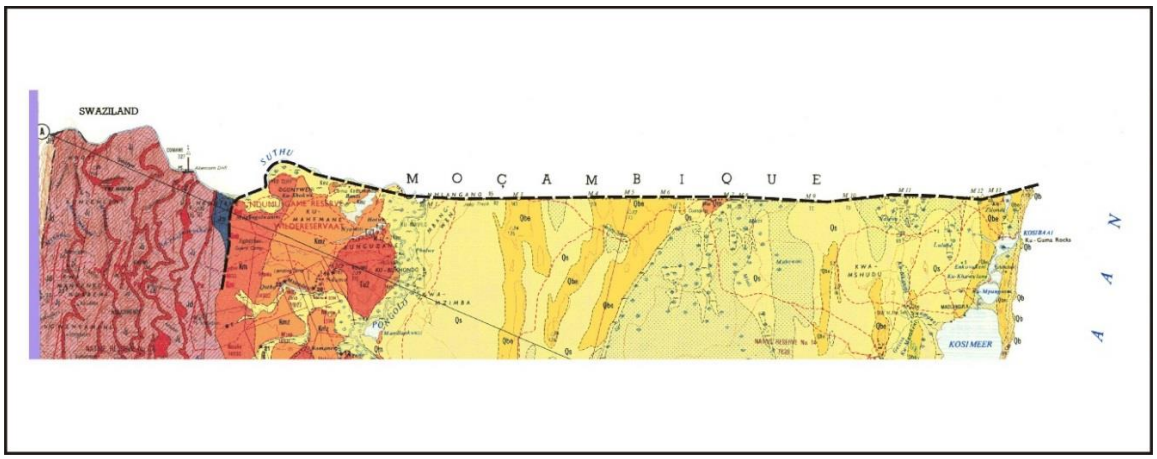

Figure 2: Geological map (1:250 000, 2632Kosi Bay) of the proposed development footprint of the KZN-Mozambique Barrier Structure. The approximate location is indicated by the black dashed line. Geological Maps are provided by the Counsel of Geosciences. Abbreviations of the rock types are explained in Table 1.

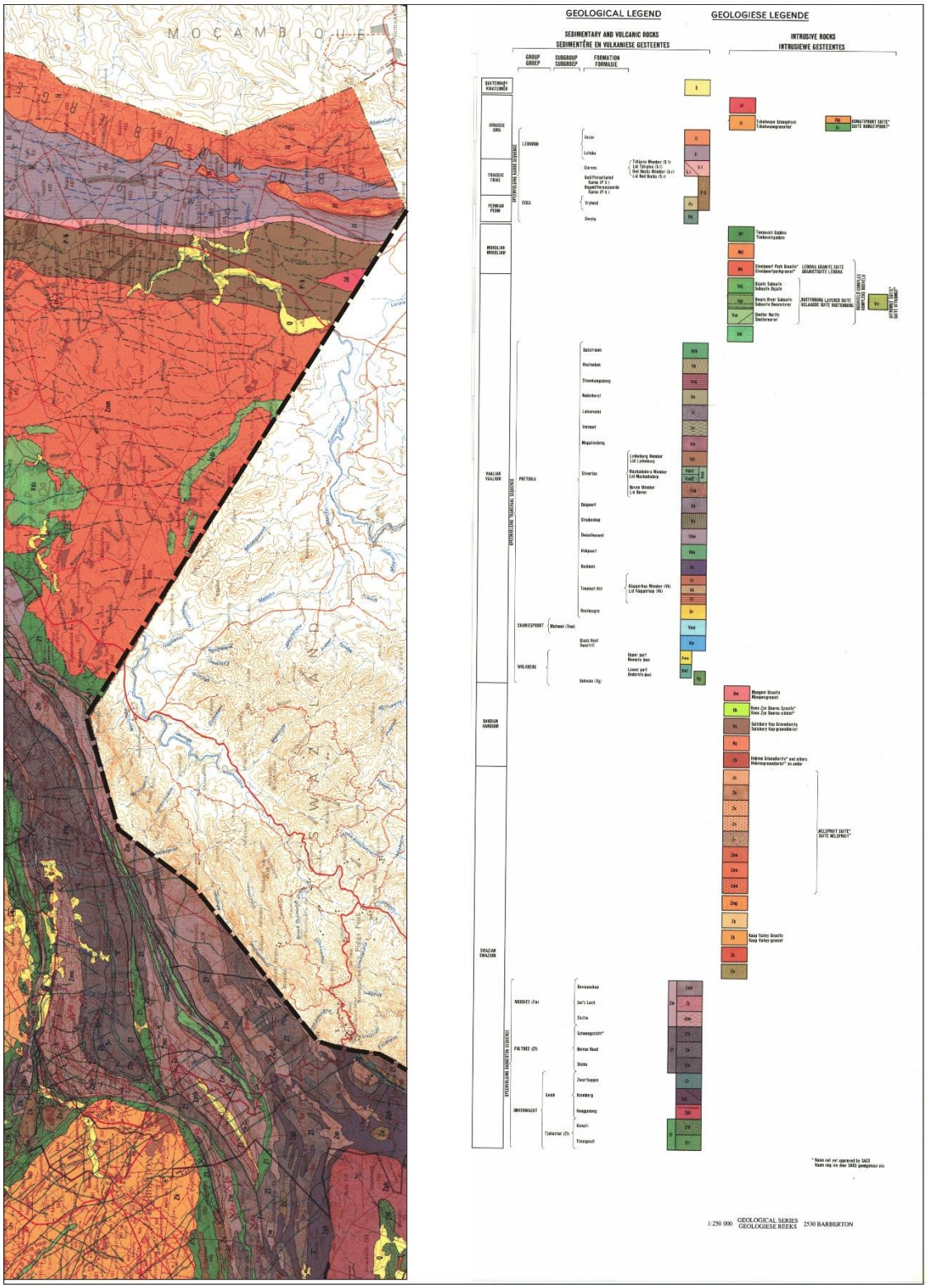

Figure 3: Geological map (1: 250 000, 3530 Barberton) of the proposed development footprint of the Swaziland-Mozambique Border Patrol Road. The approximate location is indicated by the black dashed line. Geological Maps are provided by the Counsel of Geosciences. Abbreviations of the rock types are explained in Table 1**.**

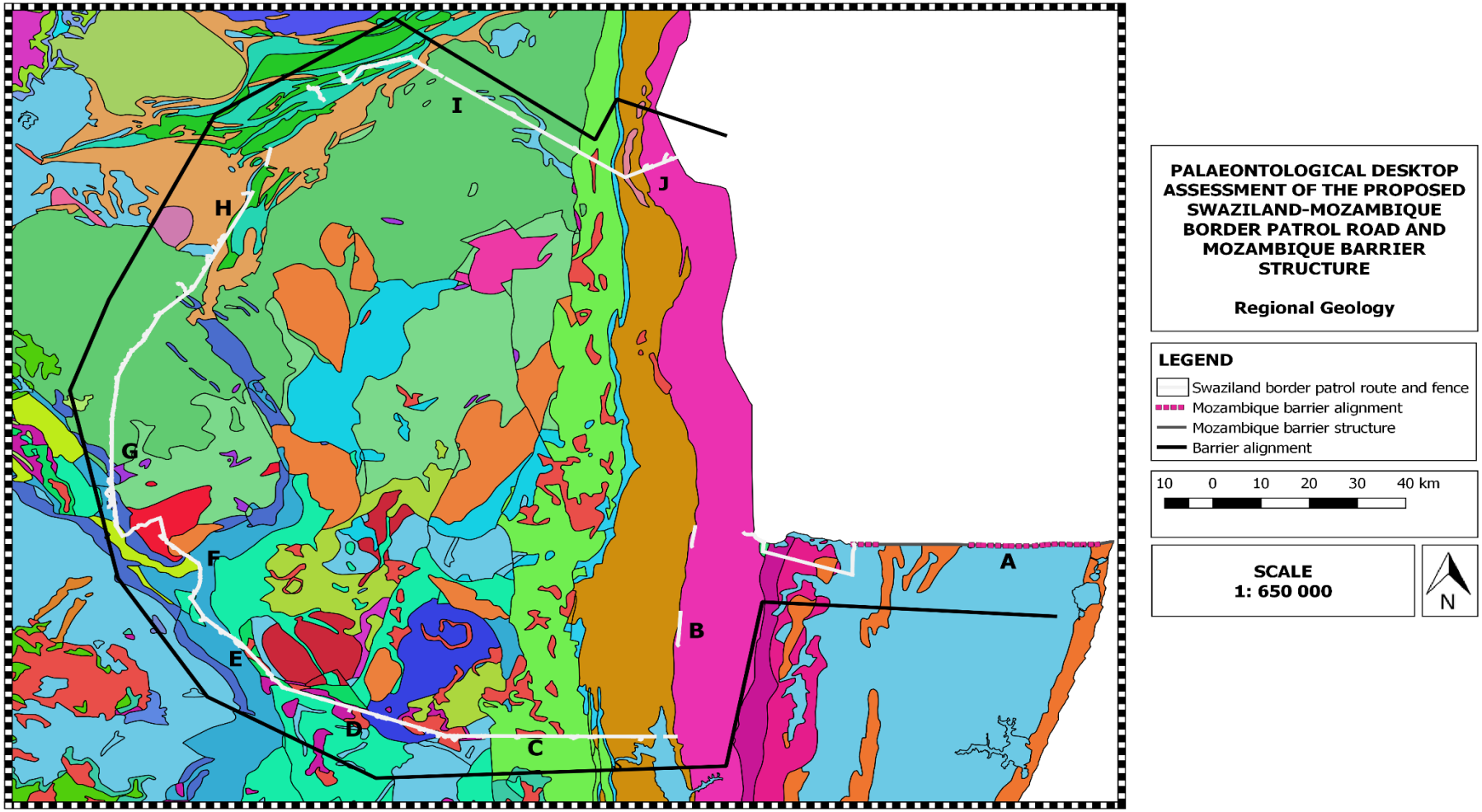

Figure 4: The surface geology of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. The map is divided into different sections for discussion purposes. Section A and J has a High to very High Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.18.12.

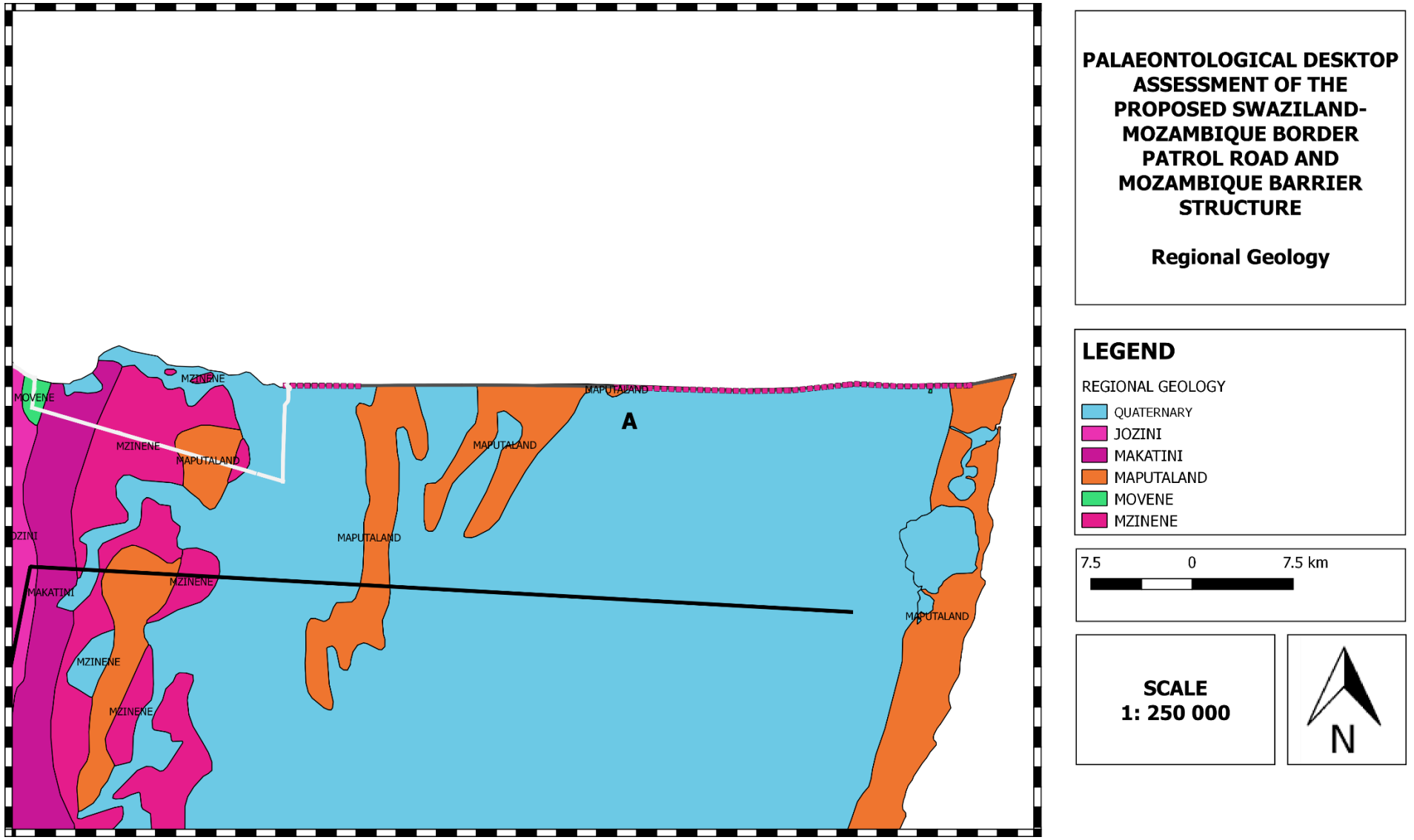

Figure 5: The surface geology of Section A of the proposed KZN-Mozambique border control barrier. The proposed development area is completely underlain by Quaternary superficial deposits of the Maputuland Group. These sediments have a high to very high Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.14.20.

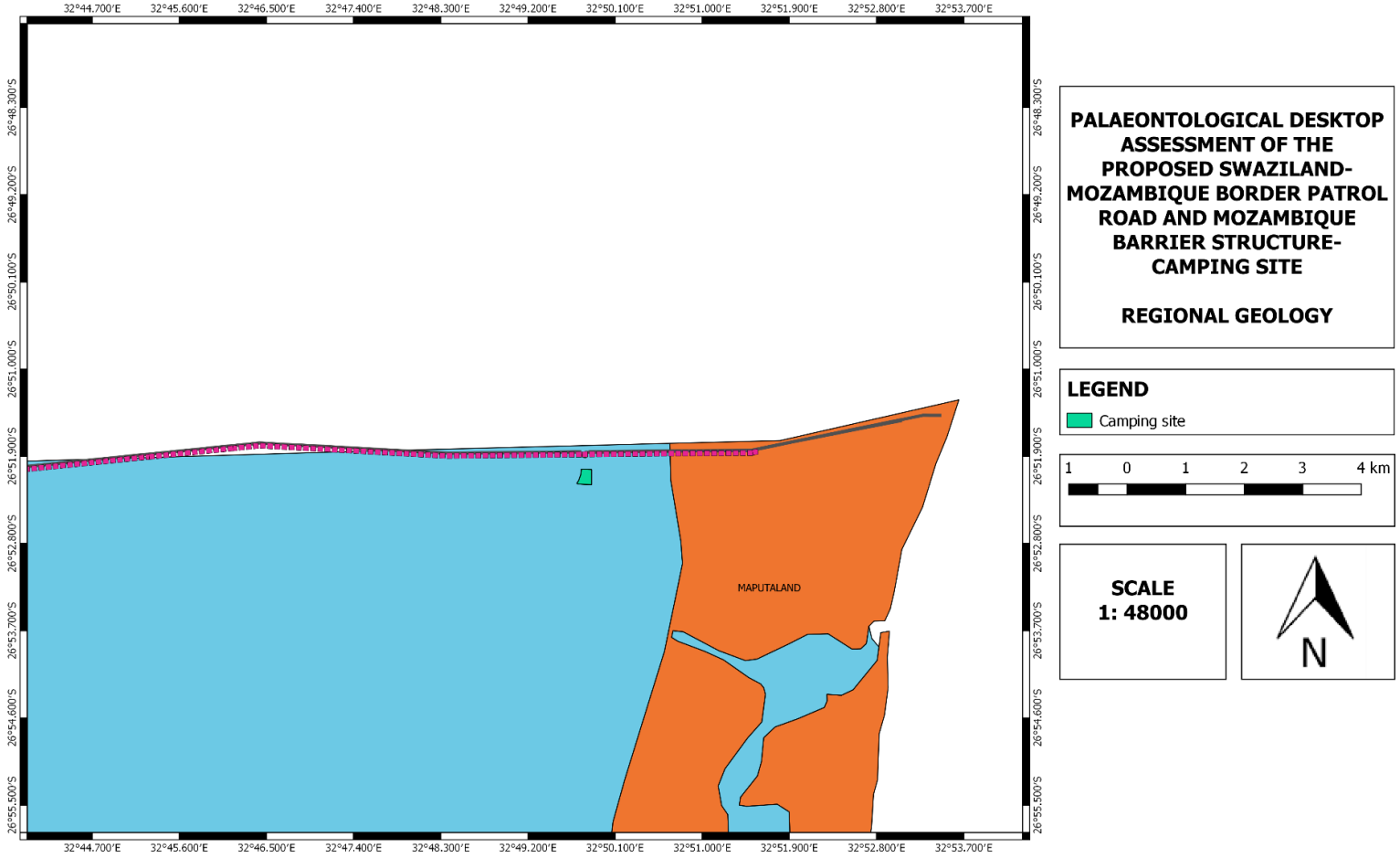

Figure 6: The surface geology of the camping site of the proposed project. The proposed development area is completely underlain Quaternary superficial deposits. Map drawn by QGIS Desktop-version 2.18.12.

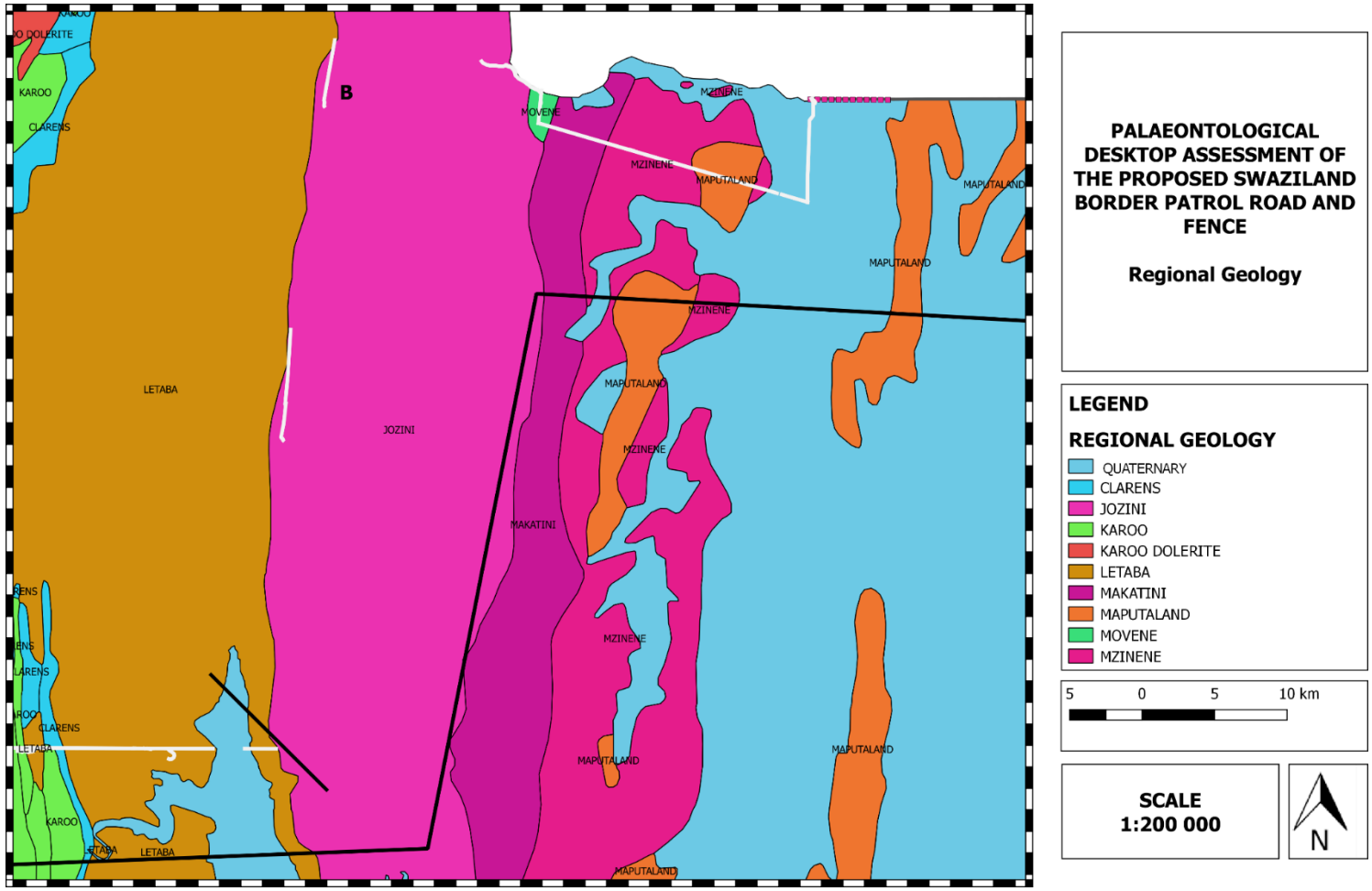

Figure 7: The surface geology of Section B of the proposed Swaziland Border Patrol Road and fence. The proposed development area is underlain by Quaternary deposits Josini and Letaba Formations, Movene and Makatini Formations. Map drawn by QGIS Desktop-version 2.14.20.

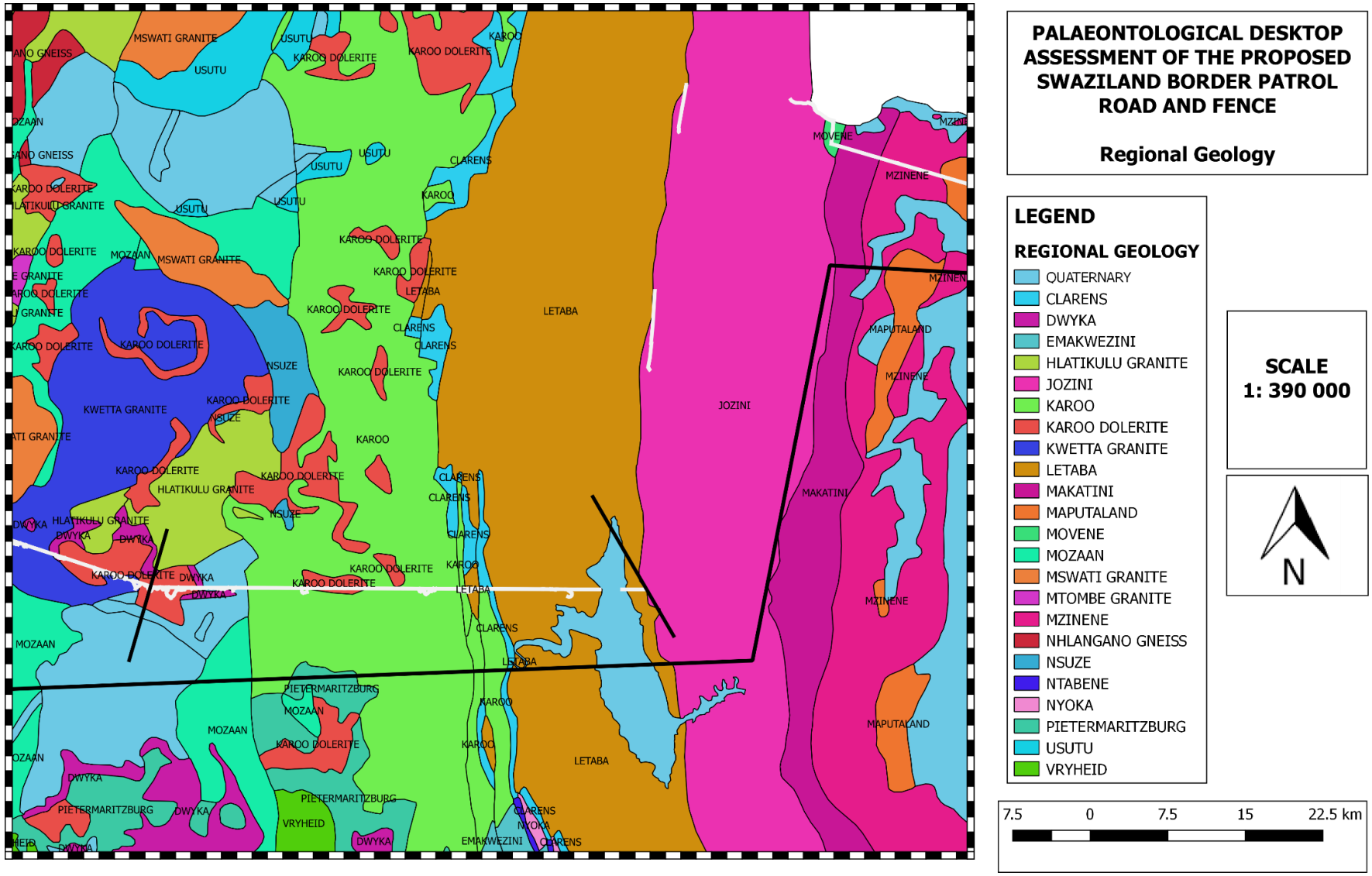

Figure 8: **The surface geology of Section C of the proposed Swaziland-Mozambique Border Patrol Road and fence. The proposed development area is completely underlain by Josine Fm, Karoo Dolerite, Dwyka, the undifferentiated Karoo, Pietermaritzburg Fm, and Mozaan Fm. Map drawn by QGIS Desktop-version 2.14.20.**

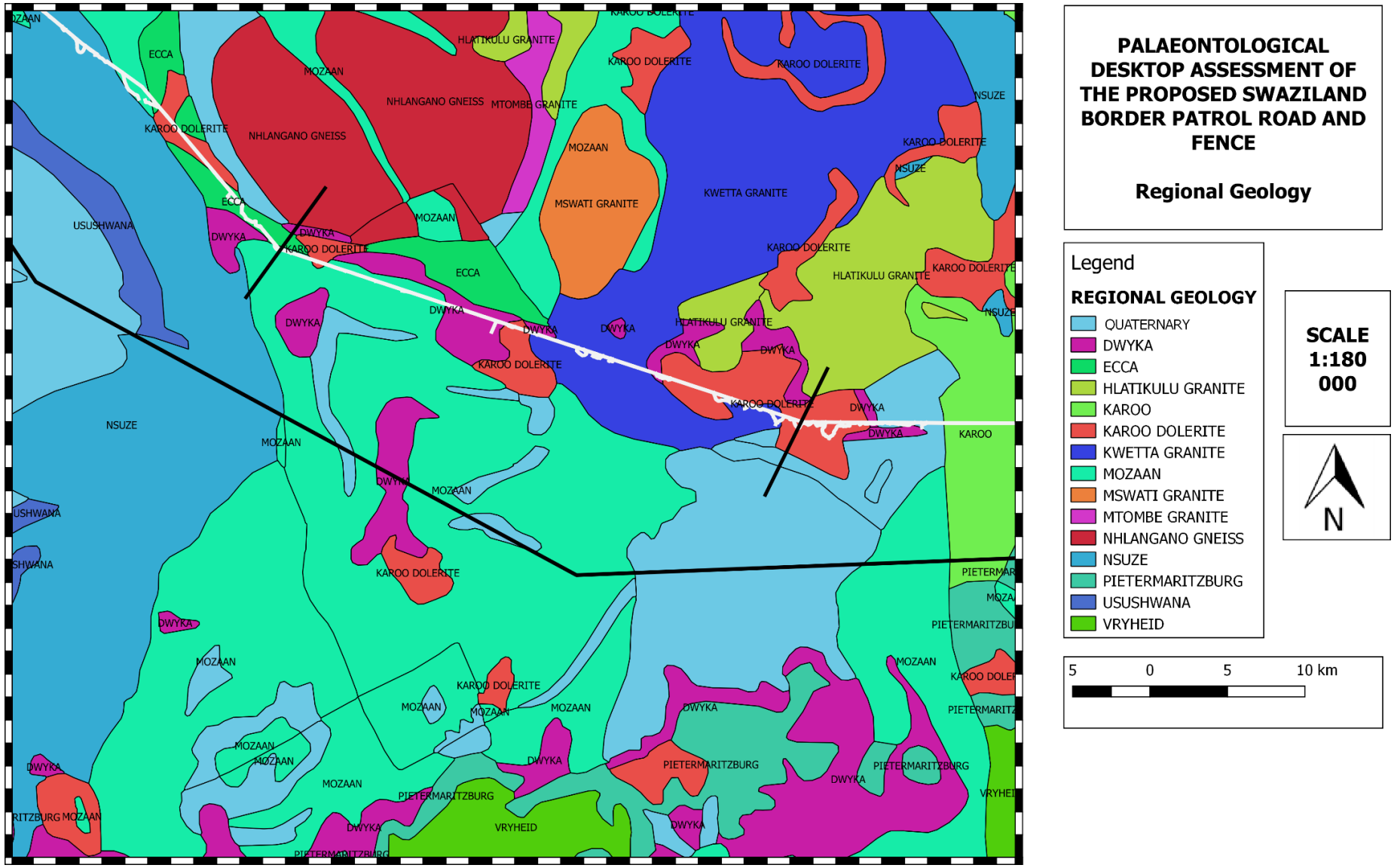

Figure 9: The surface geology of Section D of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Quaternary, Karoo dolerite, the undifferentiated Karoo, the Dwyka and Ecca Groups. Map drawn by QGIS Desktop-version 2.14.20.

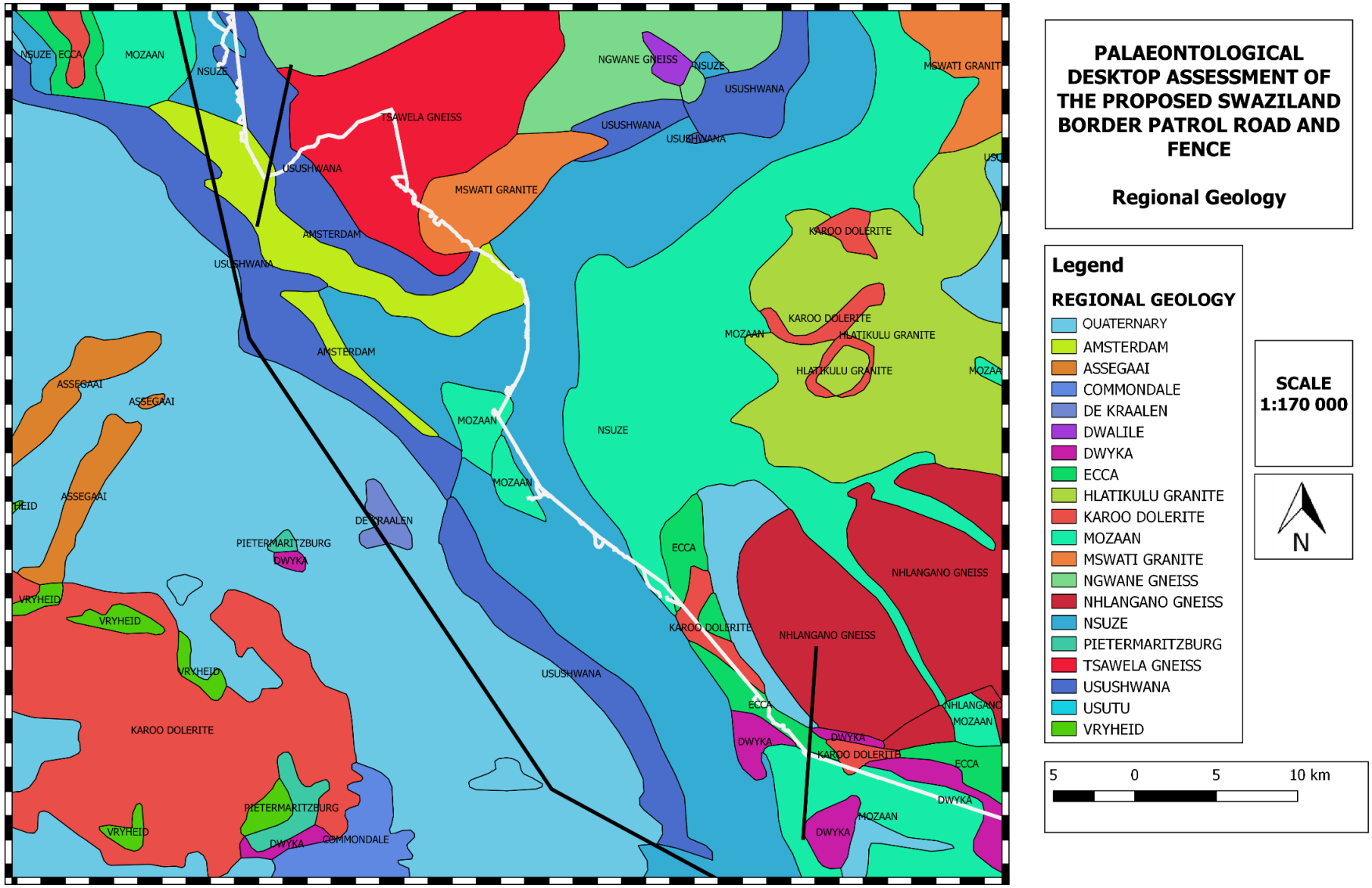

Figure 10: The surface geology of Section E of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Nsuze and Mozaan Fm, Karoo dolerite, Ecca Group and Usushwana Fm. Map drawn by QGIS Desktop-version 2.14.20.

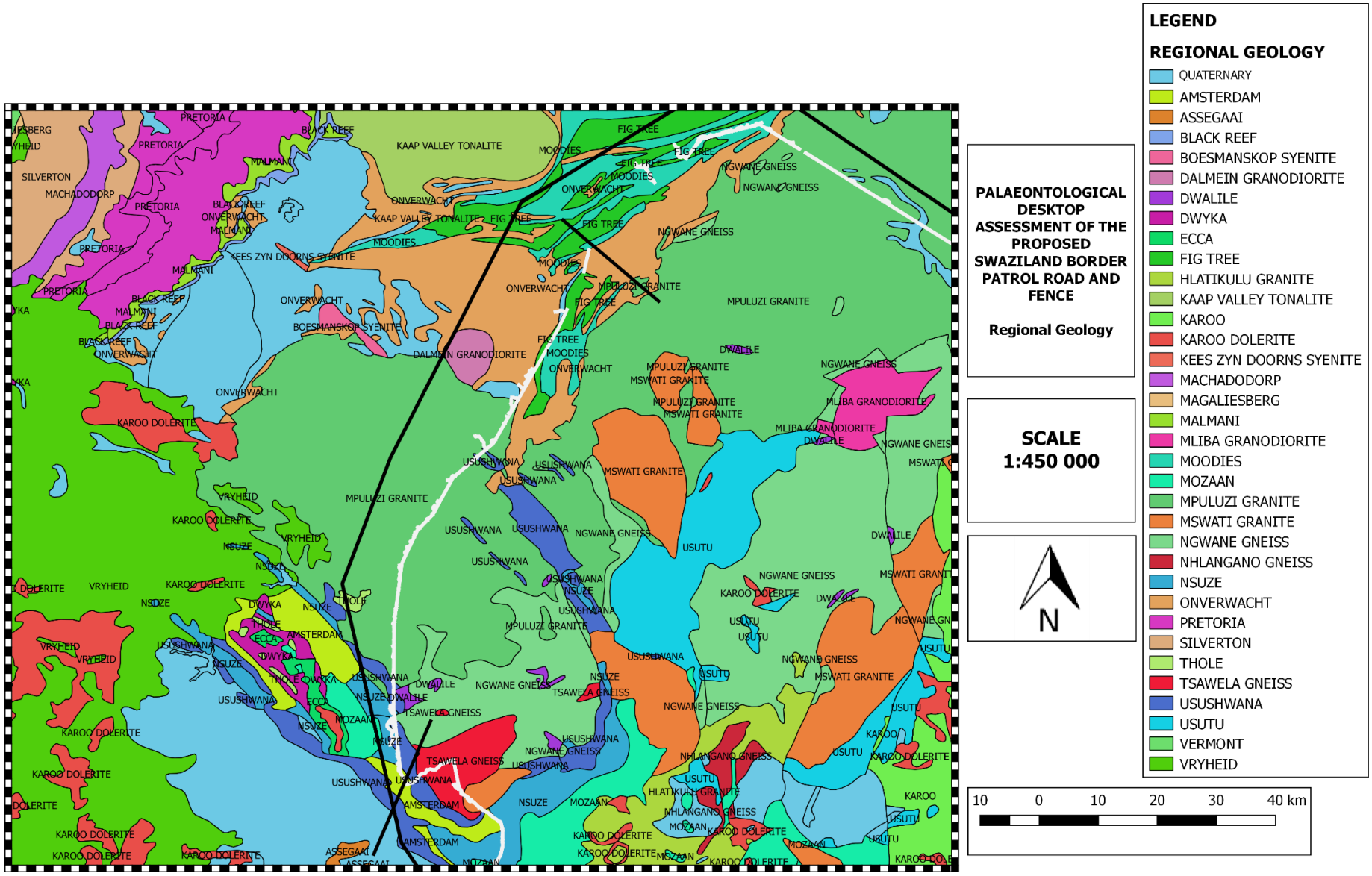

Figure 11: The surface geology of Section F of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Quaternary, Barberton Sequence, Usushwana and Nsuze Fm. Map drawn QGIS Desktop-version 2.14.20 with GRASS 7.2.2

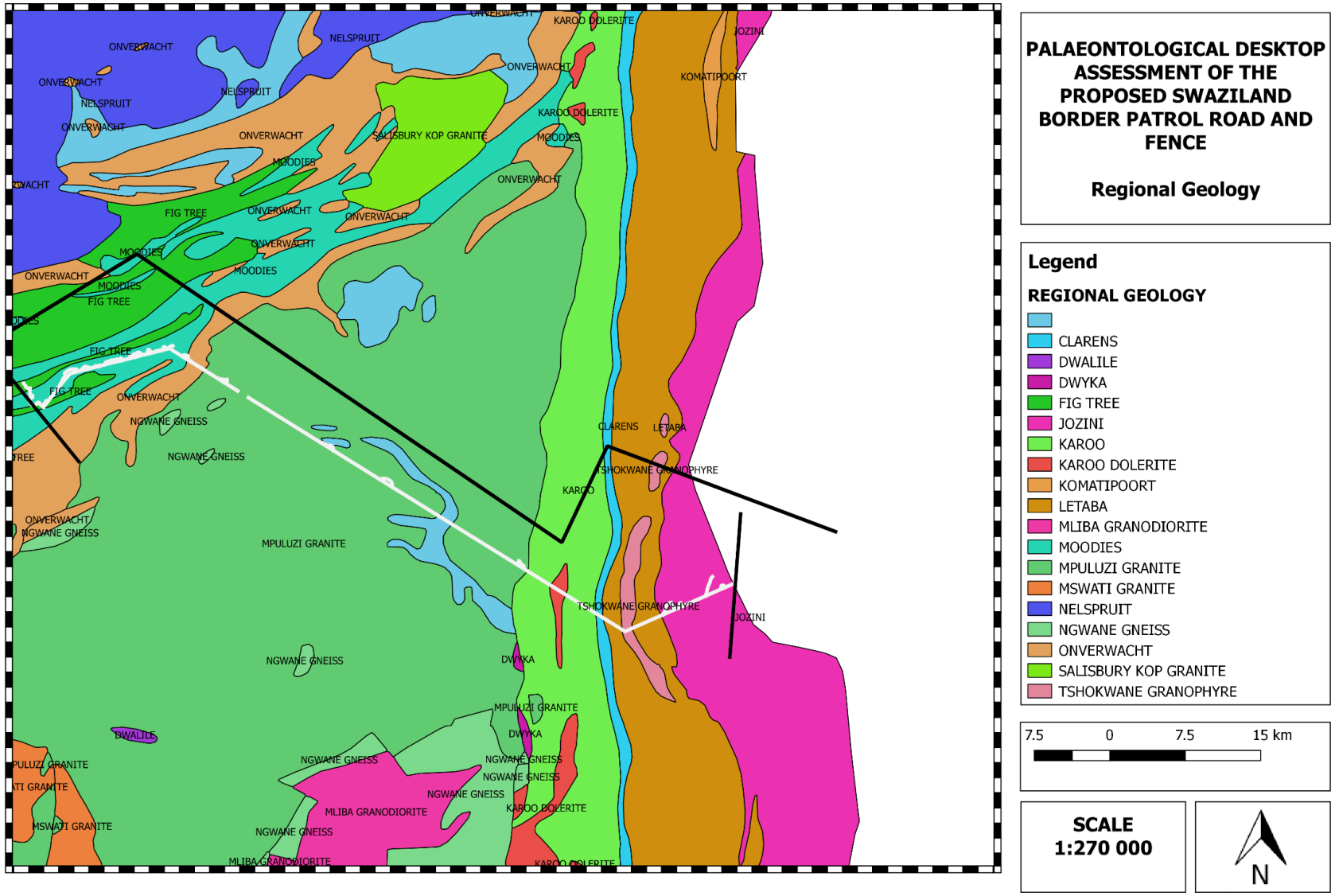

Figure 12: The surface geology of Section G of the proposed Swaziland Border Patrol Road and fence. The proposed development area is primary underlain by Mpuluzi Granite intrusive rocks, Barberton Sequence as well as the Undifferentiated Karoo. The Undifferentiated Karoo has a Very High Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.14.20 with GRASS 7.2.2.

5.1 Kwazulu-Natal

Kwazulu-Natal (2632 Kosi Bay 1:250 000 Geological Map)

The Geology of the 1:250 000 2632 Kosi Bay Geological Map is represented by Figure 2; 6 and 7 (section A). The proposed development in the KwaZulu-Natal region is underlain by the Quaternary superficial deposits; Maputuland Group (Berea, Bluff and Muzi Formations); Zululand Group (Makatini, Mzinene and St Lucia Formations); as well as while the Jozini and Movene Formations of the Karoo Igneous Province is also present .

Table 2: Palaeontological sensitivity is indicated by colour codes: Very High=-Red; High = orange. According to the SAHRIS PalaeoMap site visits is required for areas of High to Very High Palaeontological Sensitivity.

Symbol	Group/Formation	Lithology	Period
2632 Kosi Bay Geological Map Published in 1986 Sheet Explanation by Du Preez and Wolmarans 1986			
Qs	Quaternary	Aeolian sands, Yellowish redistribute sand	Cenozoic Last 2.5 Ma
Qbe	Berea Fm	Aeolianite, sand, clay, limestone	Plio-Pleistocene
Qb	Bluff Fm	Aeolianite, sand, clay, limestone	Plio-Pleistocene
Qm	Muzi Fm	Argillaceous sandstone	Cenozoic
Kmz	Zululand Gr **M**zinene Fm	Marine siltstone with shelly and concretionary horizons	Cenozoic

Cenozoic superficial deposits

The Tertiary to Quaternary Ceanozoic superficial deposits (represented on Geological maps by Q, Qw, Qs, Qg, Qc and Qm) consist of aeolian sand, alluvium (clay, silt and sand deposited by flowing floodwater in a river valley/ delta producing fertile soil), colluvium (material collecting at the foot if a steep slope), spring tufa/tuff (a porous rock composed of calcium carbonate and formed by precipitation from water, for example, around mineral springs.) and lake deposits, peats, pedocretes or duricrusts (calcrete, ferricrete), soils and gravels.

Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil biotas. Fossils assemblages may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells and freshwater stromatolites are also known from Quaternary deposits. Plant

material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts). This Group has a high Palaeontological sensitivity.

Maputuland Group

This Group spans northwards from Durban to the Mozambique coastal plains while similar deposits are also present southwards to the Eastern Cape border afterwards it becomes discontinuous. The Maputuland Group forms a layer of Tertiary and Cretaceous sequences. The last glacial period was approximately 18000 years ago. During this time the earth was much colder and the sea levels approximately 100 metres beneath the present. The coastline extended far out in the sea, while large rivers eroded deep valleys along the coast. When the earth warmed up again the sea level rose and the valleys were infilled with estuarine muds and shelly sands which now forms the Maputuland Group (65 million years ago to the present). The Maputuland group consist of the following formations: Uloa, Muzi, Port Durnford, Bluff and Berea Formations. Although only the Muzi, Bluff and Berea Formations are present in the proposed development footprint.

The Berea Formation

The Berea Formation consists of orange, red, and yellow aeolian sand in the form of dune barriers along the KwaZulu-Natal coast. Scientists is of the opinion that the Berea Formation is the surviving product of the Bluff Formation (Wolmarans and Du Preez, 1986). In Durban the Berea and Bluff Ridges are formed by the Berea Formation. Deep weathering of old dunes produced the Berea Red Sand which is dark red coloured sand. The KwaZulu-Natal coastline are currently still shaped by variations in sea-level. These deposits comprises of alluvium, calcretes and sand while the Masotchenei Formation consists of palaeosols of Cenozoic colluvial deposits.

The Berea Formation has a very high Palaeontological Sensitivity. Oyster beds are present in karst potholes and an elephant tusk was uncovered at the Umlaas Canal outfall. This formation is associated with the Last Interglacial beach

Bluff Formation

The Bluff Formation (high Palaeontological Sensitivity) is a pale brown sandstone deposit. The Bluff Formation is a nearly unbroken outcrop with fossils recorded from small deposits of coral limestone. Fossil wood can also be found in this formation. The Bluff formation consists of complex units with dune sand underlain by inland dune systems which forms the core of the coastal dune barriers. Lignite units in this formation is interpreted as an inland lake deposit.

The Muzi Formation

The Pleistocene sediments of the Muzi Formation comprises of swamp deposits consisting of mottled, brown clayey sand. This formation consists of cross-bedded aeolianite dands with a depth of up to 25m. These sands are characteristically overlying a stratified shallow marine calcarenite. The Upper surface of this formation is decalcified and rubified to form a thick covering of Berea-type red sand and is commonly karstweathered. This formation is characterised by very few outcrops and no fossils have been documented from the Muzi Formation.

Zululand Group

The Zululand Group comprises of three formations namely the Makatini, Mzinene and St Lucia Formations. The Zululand Group consist of siltstone and sandstone and are the first marine deposits that formed in the newly opened Indian Ocean. This deposits were deposited in the Cretaceous approximately 145 to 65 million years ago. The Zululand Groups is known for ammonite fossils which are large snail-like animals of up to one metre in size. These animals flourished in the warm ocean of the time. These ammonite shells can be found in almost all exposures of Cretaceous rocks.

The Zululand Group is represented in the development footprint by the Mzinene Formation. The oldest formation of the Zululand Group is the Makatini Formation (which consists of small pebble conglomerates, sandstone, siltstone and limestone of up to 80 m thick). The Makatini Formation contains large wooden fossil logs that are drilled by Teredo wood boring organisms. The overlying Mzinene Formation (present in the development footprint) has a rich invertebrate fauna which includes ammonites, bivalves, echinoids, gastropods and nautiloids. *Lithophaga*-bored concretions are commonly found which is usually covered by coarse glauconitic sands which comprises of shell-lags. The large fossil logs of this formation has also been by drilled by Teredo wood boring organisms. Fine grained sediments contain bored fossil tree trunks, small plant fragments as well as marine invertebrates. This formation has a High Palaeontological Sensitivity. Research on this formation shows that the palaeo-environment could have been a shallow-marine environment.

The Mzinene Formation comprises of glauconotic siltstone and cross-bedded sandstone while the St Lucia Formation is lithological similar to the Mzinene Formation. The upper St Lucia Formation contains an wealth of echinoid, bivalve, gastropod and cephalopod remains as well as fossil logs, plant fragments, reptile bones and at least 62 ostracod species and is much more fossiliferous than the underlying Mzinene Formation

Karoo Igneous Province

The Karoo Igneous Province consists of two groups namely the Drakensberg Group and the Lebombo Group. The latter also forms part of the proposed development footprint as it is underlain by the Movene and Jozini Formations. The Drakensberg Group formed with volcanic lava outbursts and the associated breakup of Gondwana, approximately 190 Mya. Cracks in the earth's crust were filled with molten lava that cooled to form dolerite dykes. Magma injected horizontally between sediments, cooled down and formed horizontal sills of dolerite. The last volcanic event which produced rhyolite lava formed the Lebombo Mountains. These volcanic events were followed by uplifting that in time separated Africa from Antarctica.

Lebombo Group

The Lebombo Group consist of green, fine-grained mafic lava, locally porphyritic, amygdaloidal interlayered rhyolite specifically near the top of these mountains. These Formations are igneous rocks which has a palaeontological sensitivity of zero and is thus unfossiliferous.

Table 3: Karoo Igneous Province. Table modified from (Johnson, 2006)

Karoo Igneous Province			
Drakensberg Group		Lebombo Group	
Formation	Rock Type	Formation	Rock Type
		Movene	Basalt
		Mbuluzi	Rhyolite
		Jozini	Rhyodacite
Lesotho	Basalt	Sabie River	Basalt
Barkly East	Basalt	Lethaba	Pictitic basalt
		Mashikiri	Nephelinite

5.2 Mpumalanga

The proposed development footprint is documented on Figure 8-12) in this report and represent sections C-J on those figures.

The Quaternary Cenozoic superficial deposits, Karoo Dolerite, Lebombo Group, and Josini Formation has been discussed in section 5.1.

Table 4: Explanation of symbols for the geological map and approximate ages (Cornell, et al., 2006; Marshall, 2006; Roberts et al., 1995). Fm = Formation, Gr = Group. Youngest deposits first and oldest last.

3530 Barberton Geological map Published in 1986 Sheet Explanation by F. Walraven and F.J. Hartzer			
Q	Quaternary	Superficial deposit, alluvium and scree	Cenozoic
Jd	Karoo dolerite		Jurassic
Jl	Lebombo Gr Letaba Fm	Green, fine-grained mafic lava, locally porphyritic, amygdaloidal interlayered rhyolite especially near the top	Jurassic
Jt	Tshokwane Granophyre	Intrusive rocks/ Granophyre Pink, medium grained quartz feldspar granophyre, microgranite and syenite	Jurassic
Jj	Lebombo Gr Josini Fm	Red to light brown, fine grained rhyolitic lava, porphyritic rhyolite and tuf	Jurassic
P-T	Undifferentiated Karoo	Mudrock and sandstone	Permian to Triassic
Znm	Nelspruit Suite	Intrusive rocks	Swazian
Zu	Kaap Valley Granite		Swazian
Zm Zf Zgk Zt	Barberton: Moodies Gr Barberton: Fig Tree Gr Barberton: Onverwach Gr Geluk Subgroup Kromberg Fm Tjakastad Subgroup	Predominantly volcanic igneous rocks, plus some igneous intrusions, minor sediments such as banded iron formation, chert, quartzite, conglomerate, schists	Swazian

The **Tshokwane Granophyre** consists of intrusive rocks which is approximately 140 Million years old. These intrusive rocks does not contain any fossils and thus has a zero Palaeontological Sensitivity.

Undifferentiated Karoo

The Undifferentiated Karoo has a high Palaeontological sensitivity. This group of sediments include sediments of the Dwyka, Undifferentiated Ecca, Beaufort and Lebombo Groups.

Dwyka Group

The Dwyka forms the lowermost and thus oldest deposits (approximately 300 Mya) of the Karoo Basin and is thus part of the Karoo Supergroup. The Dwyka Group, consists almost exclusively of diamictite known as the Dwyka tillite. This is a distinctive rock type which, when freshly exposed, consists of a hard fine-grained blueish-black matrix in which abundant roughly shaped clasts are embedded. These vary greatly in both lithology and size.

Plant fossils have been described from outcrops of the Dwyka. Dwyka outcrops are rare in the Mpumalanga Province and any recording of fossils would be highly significant.

Ecca Group

The Undifferentiated Ecca is divided into tree Formations namely the Pietermaritzburg, Vryheid and Volksrust Formations. The Ecca Group comprises of thick clay and silt beds and were deposited in a large sea in the Karoo Basin. These sediments now form the shales of the Pietermaritzburg Formation. The latter formation is overlain by the Vryheid Formation and is in turn overlain by the Volksrust Formation. The Ecca Group was deposited as Gondwana moved towards the equator.

The Ecca is world-renown for its plant fossils (*Glossopteris* faunal assemblage). This Group consists of sequences of sandstone and mudstone. The Ecca Group contain important resources of coal while the interbedded shale is an important source of clay for brick making. The Pietermaritzburg Formation consists of dark grey shales and usually does not have good outcrops. Fossils are thus rare and difficult to discover. This formation has a moderate palaeontological sensitivity.

Vryheid Formation

The Vryheid Formation has a Very High Palaeontological significance. This formation consist of deltaic mudrocks and sandstones, locally coastal and fluvial deposits, with occasional coal seams. This formation is the foremost coal producing formation in South Africa. Many fossils are recorded from this formation e.g. rich Permian fossil plant assemblages, *Glossopteris* Flora. Fish scales, rare insects, possible conchostracans, non-marine bivalves and many, but low diversity trace fossils have been recovered from this formation (MacRae, 1999).

Volksrust Formation

The Volksrust Formation overlies the Vryheid Formation and consists of basinal dark mudrocks with phosphatic / carbonate / sideritic concretions, as well as minor coals. These deposits consist of offshore shelf, but probably also nearshore / lagoonal / lacustrine deposits. Fossils in this formation are important, but very rare. Other fossils recorded from this formation includes minor coals with plant remains, petrified wood, low-diversity marine to non-marine trace fossil assemblages, invertebrates and rare temnospondyl amphibian remains.

Beaufort Group

The late Permian to early Triassic Beaufort Group overlies the Ecca Group. These sediments are represented in the Mpumalanga Province by only a few infrequent outcrops of the Adelaide Subgroup in the south-eastern portion of the Province. The northern outcrops of the Adelaide Subgroup is represented by the Normandien Formation which contains rich assemblages of vascular plants (*Glossopteris* Flora, including huge petrified logs) and portions of insect remains. The only vertebrate remains are limited to *Dicynodon* Assemblage Zone terrestrial and freshwater tetrapods (MacRae, 1999; McCarthy and Rubidge, 2005; Johnson et al, 2006).

The 250-million-year-old Beaufort Group contains the record of the largest known mass extinction event, namely the end-Permian mass extinction, in which most of the known species died out. The Beaufort Group is characterised by green, red and purple coloured mudstones deposited in a drying swampland.

The Triassic aged sediments of the Upper Karoo Supergroup belong to the Red Rocks Member of the Clarens Formation. These sediments are mostly red in colour and comprises of fossils of invertebrates, vertebrates (particularly dinosaurs such as "*Euskelesaurus"* and *Massospondylus*), as well as trace fossils such as *cruziana* and *skolithos*. The Tshipise Member consist of cream-coloured aeolian sandstone and playa lake deposits ("Cave Sandstone") which correlates with the Clarens Formation of Main Karoo Basin

Nelspruit Suite

The Nelspruit rocks consist of intrusive rocks which is unfossiliferous and thus have a zero Palaeontological Sensitivity.

Kaap Valley Granite

The Kaap Valley Granite: consists of granite of approximately 3227 Ma. This granite is unfossiliferous and thus have a zero Palaeontological Sensitivity.

Barberton Sequence

The Barberton Sequence of Mpumalanga consists of three Groups namely the oldest Onverwacht Group, middle Fig Tree Group and youngest Moodies group. These groups consists of mainly volcanic igneous rocks, plus some igneous intrusions, as well as minor sediments such as banded iron formation, chert, quartzite, conglomerate, schists. The Barberton Greenstone belt is almost 3500 million years old. The Onverwacht Group is divided into a lower ultramafic unit (Tjakastad Subgroup) and upper felsic unit the (Geluk Subgroup). The Geluk Subgroup is divided into the Kromberg Formation.

Archaean microbial trace fossils (bacterial borings) and microfossils and have been documented from cherts and volcanic glasses in the Fig Tree Group and Onverwacht Group of Barberton Sequence.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development follows the borders of South Africa and its neighbouring countries Mozambique and Swaziland (Fig 1).

7 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted on February 2018. This field assessment of the proposed development is completed to calculate the possible risk to the palaeontological heritage including fossil and trace fossils. A field-survey was completed on foot and by vehicle within the study area. The development footprint is then assessed by the results of the field-survey in combination with aerial photos (using Google Earth, 2018), topographical and geological maps and the author's experience. No consultations were undertaken for this Impact Assessment.

The National Defence Force is thanked for their support and escort throughout the KZN development footprint as the chance of a car hijack was eminent. It is much appreciated.

Figure 13: National Defence Force

7.1 Assumptions and limitations

The accuracy of Palaeontological Desktop Assessments is reduced by several factors which may include the following: the databases of institutions are not always up to date and relevant locality and geological information was not accurately documented in the past. Various remote areas of South Africa has not been assessed by palaeontologists and data is based on aerial photographs alone. Geological maps concentre on the geology of an area and the sheet explanations was never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas is used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally **assume** that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

8 FIELD OBSERVATIONS

The following photographs were taken on a site visit to the proposed development footprint. Only the areas in the development footprint with a High to very High Palaeontological Sensitivity (according to the SAHRIS Sensitivity Map) were evaluated. No fossils were found in the proposed development footprint although several gastropod fossils are known to the author from the Ndumo Game reserve.

High and very Palaeontological Sensitive areas at the KZN –Mozambique Border

26° 52’02”S 32°49’44”E Border post to Mozambique. No outcrops are present.	
26° 52’02”S 32°49’44”E Proposed Camp Site. Note the vegetation cover.	
26° 51’51”S 32°51’04”E Border fence and road next to the fence. No fossils were found.	

26° 50’28”S 32°52’44”E Border fence and road next to the fence. No fossiliferous outcrop.	
26° 51’48”S 32°45’60”E Border fence with lush vegetation on the other (Mozambique) side of the border	

26° 51’49”S 32°47’29”E Vegetation next to the border fence. Area is already disturbed when the original fence was erected.	
26° 52’05”S 32°41’38”E Thick unfossiliferous topsoil	
Lush vegetation without fossiliferous outcrops	

Border fence at Tembe National Elephant Park	

Very High Palaeontological Sensitive areas at the Swaziland Border

25° 55’57”S 32°45’38”E Topography next to the border fence.	
25° 55’53.73”S 32°45’38.06”E	

25° 55’58”S 32°45’03.52”E Topography of the proposed development	
25° 56’11.03”S 32°46’02.14”E Dence vegetation cover without outcrops	

9 FINDINGS AND RECOMMENDATIONS

The proposed project is underlain by various sedimentary rocks of which the **Quaternary** and the **Undifferentiated Karoo** has a **high Palaeontological sensitivity** as well as **the Zululand Group** with a **very high palaeontological sensitivity**. The various intrusive rocks have an igneous origin and is thus unfossiliferous and has a zero palaeontological sensitivity. As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in February 2018 to assess the potential risk to palaeontological material (fossil as well as trace fossils) in the proposed footprint of the development. A physical field-survey of the proposed development and camping site was conducted on foot and by vehicle and during this field survey, **no fossiliferous outcrops** were found in the development footprint. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Although fossils are uncommon and only occur periodically 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.

The scarcity of fossil heritage at the proposed development footprint indicate that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

In the unlikely 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 should be protected (preferably *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.

10 INTRODUCTION: IMPACT ASSESSMENT METHODOLOGY

Impact assessment must take account of the nature, scale and duration of effects on the environment, whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages from planning, through construction and operation to the decommissioning phase. Where necessary, the proposal for mitigation or optimisation of an impact is noted. A brief discussion of the impact and the rationale behind the assessment of its significance is provided in this Section.

The EIA of the project activities is determined by identifying the environmental aspects and then undertaking an environmental risk assessment to determine the significant environmental aspects. The environmental impact assessment is focussed on the following phases of the project namely:

- Planning Phase;
- Construction Phase; and
- Operational Phase.

As the project entails rehabilitation of existing infrastructure which will be permanent, decommissioning is not applicable to this project, however, impacts associated with post construction clean-up are considered.

10.1 IMPACT ASSESSMENT METHODOLOGY

The potential environmental impacts associated with the project will be evaluated according to its nature, extent, duration, intensity, probability and significance of the impacts, whereby:

- ***Nature:*** A brief written statement of the environmental aspect being impacted upon by a particular action or activity;
- ***Extent:*** The area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact. For example, high at a local scale, but low at a regional scale;
- ***Duration:*** Indicates what the lifetime of the impact will be;
- ***Intensity:*** Describes whether an impact is destructive or benign;
- ***Probability:*** Describes the likelihood of an impact actually occurring; and
- ***Cumulative:*** In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

The criteria to be used for the rating of impacts are provided in **Table 8-1**.

Table 5: Criteria to be used for the rating of impacts

Criteria	Description			
EXTENT	**National (4)** The whole of South Africa	**Regional (3)** Provincial and parts of neighbouring provinces	**Local (2)** Within a radius of 2 km of the construction site	**Site (1)** Within the construction site
DURATION	**Permanent (4)** Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient	**Long-term (3)** The impact 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. The only class of impact which will be non-transitory	**Medium-term (2)** The impact will last for the period of the construction phase, where after it will be entirely negated	**Short-term (1)** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase
INTENSITY	**Very High (4)** Natural, cultural and social functions and processes are altered to extent that they permanently cease	**High (3)** Natural, cultural and social functions and processes are altered to extent that they temporarily cease	**Moderate (2)** Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way	**Low (1)** Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected
PROBABILITY OF OCCURRENCE	**Definite (4)** Impact will certainly occur	**Highly Probable (3)** Most likely that the impact will occur	**Possible (2)** The impact may occur	**Improbable (1)** Likelihood of the impact materialising is very low

Significance is determined through a synthesis of impact characteristics. Significance is also 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 total number of points scored for each impact indicates the level of significance of the impact.

Table 6: Criteria for the rating of classified impacts

	Class	Description
+	**Any value**	Any positive / beneficial 'impact', i.e. where no harm will occur due to the activity being undertaken.
–	**Low impact (4 -6 points)**	A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
	Medium impact (7 -9 points)	Mitigation is possible with additional design and construction inputs.
	High impact (10 -12 points)	The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.
	Very high impact (12 - 14 points)	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a "very high impact" is likely to be a fatal flaw.
Status		Denotes the perceived effect of the impact on the affected area.
Positive (+)		Beneficial impact.
Negative (-)		Deleterious or adverse impact.
Neutral (/)		Impact is neither beneficial nor adverse.
It is important to note that the status of an impact is assigned based on the *status quo* – i.e. should the project not proceed. Therefore, not all negative impacts are equally significant.		

The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented. Mitigation measures identified as necessary will be included in an EMPr.

10.2 POTENTIAL IMPACTS AND SIGNIFICANCE

The following sections will provide a description of the potential impacts as identified by the specialist assessment, EAP and through the PPP as well as the assessment according to the criteria described in **Table 8-1** and **8-2**.

All potential impacts associated by the proposed development through the construction and operation of the development life-cycle have been considered and assessed in the following sections. As the infrastructure is expected to be permanent, the decommissioning phase impacts have not been considered.

It must be noted that any impact on the Palaeontological Heritage will only be during the CONSTRUCTION phase and that only the Areas of High and Very High Palaeontological Sensitivity will be impacted upon.

10.2.1 Construction Phase Impacts

Table 7: Construction phase impacts

Phase	Potential Aspect and/or Impact	Mitigation	Extent (E)	Duration (D)	Intensity (I)	Probability (P)	Significance (E+D+I+P)	
Construction	**Aspect:** ***T***he 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 permanently close-in fossils at or below the ground surface. These fossils will then be lost for research. **Impact:** Destruction of fossil Heritage	**Without**	1	4	1	2	-8	**Medium Negative**

Phase	Potential Aspect and/or Impact	Mitigation	Extent (E)	Duration (D)	Intensity (I)	Probability (P)	Significance (E+D+I+P)	
	Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography	**With**	1	4	1	1	-7	Medium Negative
		Key mitigation measures: *Not necessary* In the event that fossil remains are discovered during any phase of construction, either on the surface or unearthed by fresh excavations, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (preferably *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 approved collection which comprises a museum or university collection, while all fieldwork and reports should meet the minimum standards for palaeontological impact studies proposed by SAHRA. The lack of appropriate exposure at the proposed development footprint indicates that the impact of the development is of low significance in palaeontological terms						

The numbering included in the above tables came as a result of Table **7.**

CONTENT OF SPECIALIST REPORTS ACCORDING TO APPENDIX 6 OF THE EIA REGULATIONS 2014 AS AMENDED IN 2017

(1) A specialist report prepared in terms of these Regulations must contain-

a) details of-

(i) the specialist who prepared the report; and

(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

c) an indication of the scope of, and the purpose for which, the report was prepared;

d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

e) a description of the methodology adopted in preparing the report or carrying out the specialised process;

f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

g) an identification of any areas to be avoided, including buffers;

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;

i) a description of any assumptions made and any uncertainties or gaps in knowledge;

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;

k) any mitigation measures for inclusion in the Environmental Management Programme (EMPr);

l) any conditions for inclusion in the environmental authorisation;

m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

n) a reasoned opinion- (i) as to whether the proposed activity or portions thereof should be authorised; and (ii) if the opinion is that the proposed activity 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;

o) a description of any consultation process that was undertaken during the course of preparing the specialist report;
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
q) any other information requested by the competent authority.
r) Original signed specialist declaration.

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