PALAEONTOLOGICAL IMPACT ASSESSMENT: UPGRADE OF N10 SECTION 3 FROM THE RIET RIVER (KM45.2) TO TARKA BRIDGE (KM68.5)

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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EXECUTIVE SUMMARY

The South African National Roads Agency (SANRAL) is proposing to upgrade a 23.3km section of the National Route (R61) between Cradock and Middleburg along the Mountain Zebra Park in the Eastern Cape Province.

The proposed activity includes widening the existing section of road to a minimum width of 12.4m. Climbing lanes may be required where necessary. The widening will also include the widening of all stormwater structures along the length of the project.There may also be possible bridge and major culvert construction. The road will not result in the widening of the road reserve boundaries and should not intrude into private-owned land at any point.

A mining license application will also be submitted for a possible quarry site once it has been approved in the Scoping Report by the Department of Mineral Resources (DMR). This is in accordance with the regulations pertaining to the Minerals and Petroleum Resources Development Act (Act No.28 of 2002) regulated by the Department of Mineral Resources.

The proposed development falls within the requirements for a heritage impact assessment as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999).

The entire study area is underlain by strata of the middle to upper Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup), including the mudstone dominated Daggaboesnek Member, and the sandstone dominated Barberskrantz Member. These are intruded by dolerite dykes and sills implaced during the Jurassic.

The flood planes of the Beaufort Group (Karoo Supergroup) provide an internationally important record of life during the early diversification of land vertebrates. During its deposition giant amphibians coexisted with diapsid reptiles (the ancestors of dinosaurs, birds and most modern reptiles), anapsids (which probably include the ancestors of tortoises) and synapsids, the dominant group of the time which included the diverse therapsids (including the ancestors of mammals).

Consultation with collection accession databases reveal that the Council of Geosciences is in possession of 3 therapsid specimens (belonging to the Dicinodontia) which were collected within three kilometres of the road. Two of these were collected to the east of the southern region of the study area, where they were also within a few kilometres of the proposed Bonthoek borrow pit. One was collected to the west of the northern limit of the study area, within a few kilometres of the proposed Low Land borrow pit.

A Site Survey was carried out on the 21st of july 2012. It was established that this section of road is by and large situated on a raised bed situated along the valley bottom of the Fish River. As a result very little palaeontological bedrock is exposed.

It is concluded that the construction of the road itself will have a very low chance of impacting on palaeontological resources and this only in a very limited area. No mitigation will therefore be required before, during or after the envisioned works.

A number of borrow pit sites were also examined. There is a reasonable chance that palaeontological material in the form of **vertebrate fossils will be exposed during development of the Lowlands and Tarka Training Farm borrowpits** as these are situated within a few kilometres of significant previous finds. It is therefore recommended that if these sites are utilised mitigation should be undertaken. This should include **a meeting between a palaeontologist, the EO and the foreman, shortly after the sites have been opened**, in order to explain to them what to look out for and to have an initial inspection. Secondly **these two borrow pits should be examined for fossils at the end of aggregate extraction**, prior to rehabilitation.

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

TYPE OF ASSESSMENT: NAME OF PROJECT

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

SIGNATURE:

TABLE OF CONTENTS

INTRODUCTION

1.1 Background Information

The South African National Roads Agency (SANRAL) is proposing to upgrade a 23.3km section of the National Route (R61) between Cradock and Middleburg along the Mountain Zebra Park in the Eastern Cape Province (Figure 1.1). Worley Parsons has been appointed by SANRAL as the project managers who subcontracted Coastal & Environmental Services (CES) as the Environmental Assessment Practitioner (EAP).

The proposed activity includes widening the existing section of road to a minimum width of 12.4m. Climbing lanes may be required where necessary. The widening will also include the widening of all stormwater structures along the length of the project.. There may also be possible bridge and major culvert construction. The road will not result in the widening of the road reserve boundaries and should not intrude into private-owned land at any point.

A mining license application will also be submitted for a possible quarry site once it has been approved in the Scoping Report by the Department of Mineral Resources (DMR). This is in accordance with the regulations pertaining to the Minerals and Petroleum Resources Development Act (Act No.28 of 2002) regulated by the Department of Mineral Resources.

1.2 Terms of Reference

The Palaeontological Impact Assessment was intended to:

Identify palaeontologically sensitive strata to be impacted by the development.

Examine all relevant outcrops to establish what palaeontological resources are exposed on site.

Evaluate palaeontological resources in terms of significance and sensitivity.

Suggest appropriate mitigatory measures to rescue, record or protect important palaeontological material

1.3 The study team

Robert Gess is a research associate of the Albany Museum in Grahamstown, and lectures in palaeontology at Rhodes University. He has more than 15 years experience in Palaeontolgical research in the Eastern Cape, and is currently South Africa’s primary researcher on South African Devonian Palaeoichthyology and Palaeobotany. He has published numerous papers in international peer-reviewed journals, and regularly presents his research at conferences, both locally and internationally. He is a SAHRA and PSSA approved Palaeontology Heritage Assessor and has extensive experience performing EIA studies.

Professional Affiliations

- Member of the Paleontological Society of South Africa (PSSA)
- Research Associate of Albany Museum, Grahamstown

Education

- Phd (Palaeontology), 2011
- Msc (Palaeontology), 2003
- Hde (Geography, Science, Biology), 1992
- Bsc (Geology and Zoology), 1991

Palaeontological Papers in Peer-reviewed Journals

Gess, R.W. (2012). The oldest animals (*comment and opinion*), *South African Journal of Science* **108**,**1**: 1.

Gess, R.W., 2001. A new species of *Diplacanthus* from the Late Devonian (Famennian) of South Africa. *Annales de Paléontologie* **87**, 49-60.

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1.4 Relevant legislation

The proposed development falls within the requirements for a heritage impact assessment as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

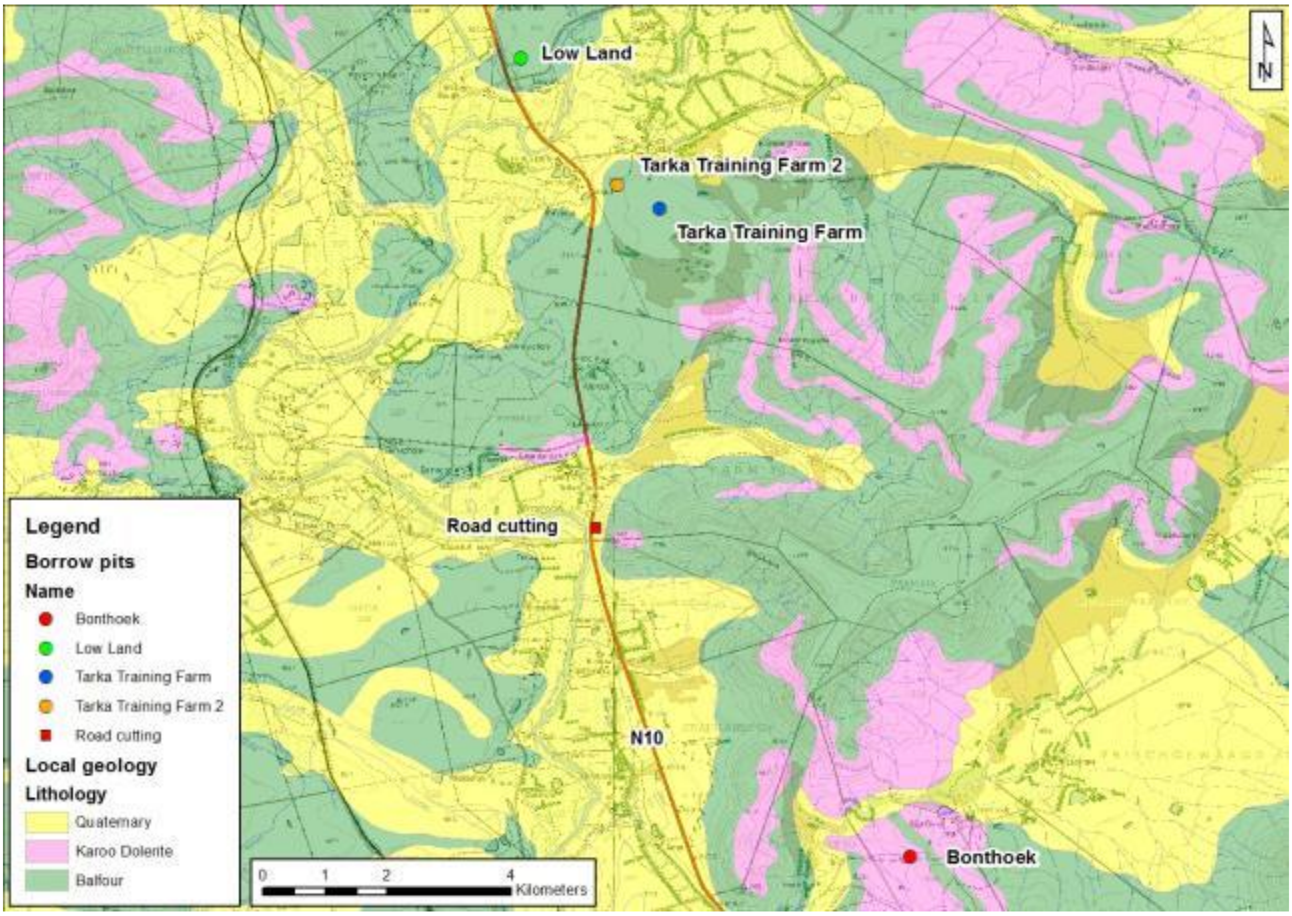

Figure 1: Topography of study area superimposed on Geological survey data. Round dots represent proposed borrow pit sites.

1.5 Approach to Study

1.5.1 Study area assessment

A short desktop study was conducted to ascertain the palaeontological potential of the geological strata affected by the project. This included reference to geological maps and literature.

A survey was also conducted of identified vertebrate palaeontological material accessioned into South African collections.

All outcrops along the route were rigorously examined as well as any outcrop available in or adjacent to proposed quarry and borrow pit sites. All features of palaeontological interest were documented.

A report was composed detailing the above gathered information and evaluating whether appropriate mitigation is required

1.5.1 Impact rating methodology

To ensure a balanced and fair means of assessing the significance of potential impacts a standardised rating scale was adopted in the EIA phase. This rating scale will also be used to allow the direct comparison of specialist studies.

This rating scale adopts four key factors that are generally recommended as best practice around the world that include:

1. **Temporal Scale**: This scale defines the duration of any given impact over time. This may extend from the short- term (less than 5 years or the construction phase) to permanent. Generally the longer the impact occurs the more significance it is.
2. **Spatial Scale:** This scale defines the spatial extent of any given impact. This may extend from the local area to an impact that crosses international boundaries. The wider the impact extends the more significant it is considered.
3. **Severity/Benefits Scale:** This scale defines how severe negative impacts would be, or how beneficial positive impacts would be. This negative/positive scale is critical in determining the overall significance of any impacts.
   The Severity/Benefits Scale is used to assess the potential significance of impacts prior to and after mitigation in order to determine the overall effectiveness of any mitigations measures.
4. **Likelihood Scale:** This scale defines the risk or chance of any given impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.

These four scales are ranked and assigned a score, as presented in Table 1-1 to determine the overall impact significance. The total score is combined and considered against Table 1-2 to determine the overall impact significance.

1.6 Assumptions and Limitations

The geology of the area is extrapolated during the desk top phase from geological maps, which are sometimes not minutely accurate, requiring field assessment to verify them.

Field assessment is often hampered by the lack of outcrop, soil and vegetation cover in an area which is to be impacted by excavations. This may make it difficult to estimate what is likely to be present underground.

Although the likelihood of important fossils being impacted during deep excavations can be estimated, only presence during the excavation can provide certainty regarding the local concentration of material.

1.7 Sensitivity Assessment methodology

Table 1-1: Ranking of Evaluation Criteria

				Score
EFFECT	**Temporal scale**			**Score**
	Short term	Less than 5 years		**1**
	Medium term	Between 5 and 20 years		**2**
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.		**3**
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there		**4**
	Spatial Scale			
	Localised	At localised scale and a few hectares in extent		**1**
	Study area	The proposed site and its immediate environs		**2**
	Regional	District and Provincial level		**3**
	National	Country		**3**
	International	Internationally		**4**
	*	**Severity**	**Benefit**	
	Slight / Slight Beneficial	Slight impacts on the affected system(s) or party(ies).	Slightly beneficial to the affected system(s) or party(ies).	**1**
	Moderate / Moderate Beneficial	Moderate impacts on the affected system(s) or party (ies).	An impact of real benefit to the affected system(s) or party(ies).	**2**
	Severe / Beneficial	Severe impacts on the affected system(s) or party(ies).	A substantial benefit to the affected system(s) or party(ies).	**4**
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party (ies).	A very substantial benefit to the affected system(s) or party(ies).	**8**
LIKELIHOOD	**Likelihood**			
	Unlikely	The likelihood of these impacts occurring is slight		**1**
	May Occur	The likelihood of these impacts occurring is possible		**2**
	Probable	The likelihood of these impacts occurring is probable		**3**
	Definite	The likelihood is that this impact will definitely occur		**4**

** In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know*

DESCRIPTION OF THE AFFECTED ENVIRONMENT

Geology and Palaeontology

The entire study area is underlain by strata of the middle to upper **Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup**), including the mudstone dominated Daggaboesnek Member, and the sandstone dominated Barberskrantz Member. These are intruded by dolerite dykes and sills implaced during the Jurassic.

The strata of the **Karoo Supergroup** were deposited within the Karoo sedimentary Basin, which resulted from shortening and thickening of the southern margin of Africa, with coeval folding and uplift of the Cape Supergroup strata along its southern margin. The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods. During this interval the basin evolved from an inland sea flooded by a melting ice cap, to a giant lake (the Ecca Lake) fed by seasonal meandering (and at times braided) rivers. This lake steadily shrank as it filled with sediment and the basin's rate of subsidence stabilised. As the lake shrank the plains behind the shoreline grew. Rivers crossing the plains deposited sediment as channel fills and overbank flood deposits. The land became increasingly arid and was covered with wind- blown sand towards the end of its cycle. Finally the subcontinent was inundated with basaltic lava that issued from widespread linear cracks within the crust, to form the capping basalts of the Drakensberg Group.

The flood planes of the **Beaufort** Group (Karoo Supergroup) provide an internationally important record of life during the early diversification of land vertebrates. During its deposition giant amphibians coexisted with diapsid reptiles (the ancestors of dinosaurs, birds and most modern reptiles), anapsids (which probably include the ancestors of tortoises) and synapsids, the dominant group of the time which included the diverse therapsids (including the ancestors of mammals). Rocks of the Beaufort Group provide the world's most complete record of the important transition from early 'reptiles' to mammals.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content. The Daggaboersnek and Barberskrantz Members of the Balfour Formation fall within the *Dicynodon* Assemblage Zone (Figure 2).

The *Dicynodon* Assemblage Zone is characterised by the co-occurrence of two therapsids, *Dicynodon* and *Theriognathus.* It demonstrates the Beaufort Groups greatest diversity of vertebrate taxa, including numerous genera and species of dicynodont, biarmosuchian, gorgonopsian therocephalian and cynodont therapsid Synapsida, together with diverse captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Fish. Trace fossils of invertebrates and vertebrates as well as *Glossopteris* flora plants have also been described.

During the formation of the volcanic **Drakensberg Group (Stormsberg Group, Karoo Supergroup)**, during the Jurassic, crack like fissures in the earth's crust became filled with molten lava that later cooled to form dolerite dykes. Other magma was injected under pressure between horizontal sedimentary strata and cooled to form extensive horizontal sills of dolerite. Dolerite, being an intrusive igneous rock, contains no fossils.

Much of the area is covered in a thick deposit of Quaternary alluvium some of which has been calcretised. This is unlikely to contain palaeontologically sensitive material.

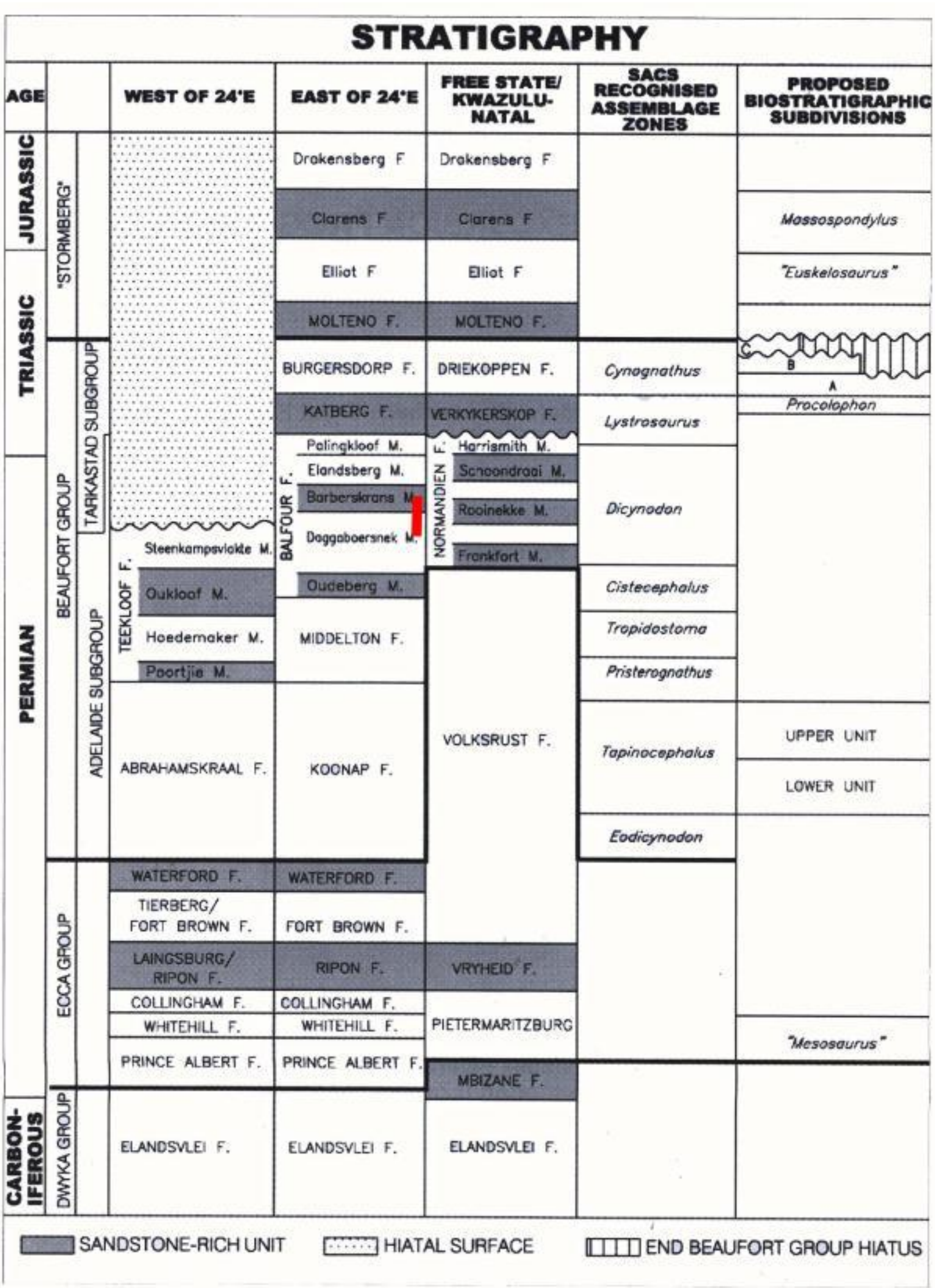

Figure 2. : Karoo stratigraphy and biostratigraphy (after Smith *et al*., 2012). Red line indicates stratigraphic interval impacted by proposed development.

Consultation with collection accession databases reveal that the Council of Geosciences is in possession of 3 specimens of Dicinodontia collected within three kilometres of the road. Two of these were collected to the east of the southern region of the study area, where they were also within a few kilometres of the proposed Bonthoek borrow pit. One was collected to the west of the northern limit of the study area, within a few kilometres of the proposed Low Land borrow pit.

KEY FINDINGS OF THE SPECIALIST STUDY

A **Site Survey** was carried out on the 21st of july 2012. It was established that this section of road is by and large situated on a raised bed situated along the valley bottom of the Fish River. As a result very little palaeontological bedrock is exposed. This consists of a single roadcutting where the road is incised into the toe of a spur of a hill. Here fine-grained green mudstones are exposed (fig. 3, top). Slabs of thin sandstone beds from above the road cut surface reveal impressions of shallow water ripples some of which are overlain by probable vegetation drag marks (fig. 3, *middle*) and others by desiccation cracks (fig.3, bottom).

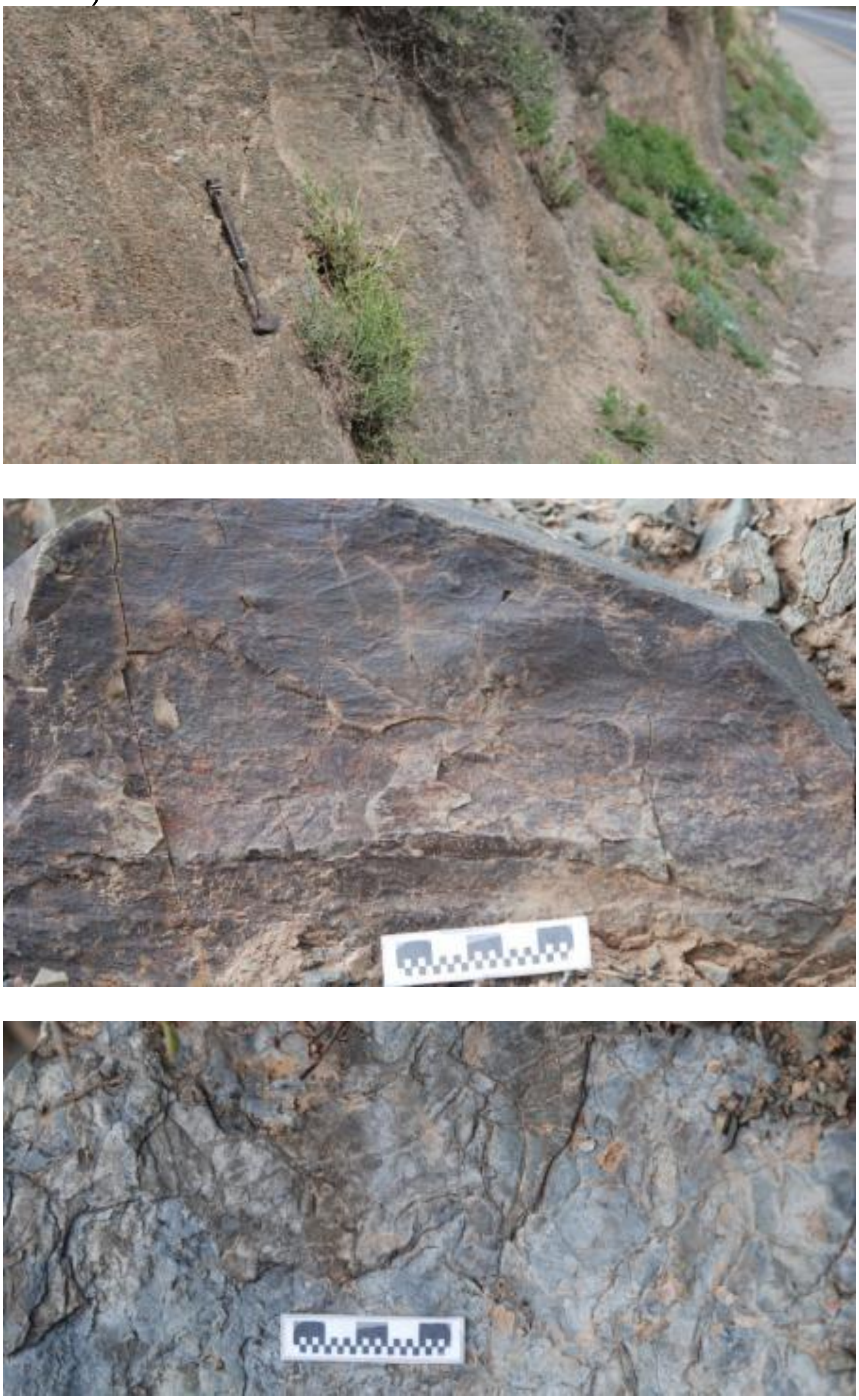

Figure 3: Roadcutting (see fig.1) *top*: mudstone; *middle*: palaeo water ripples with probable plant drag marks; *bottom*: palaeo water ripples superimposed by mud crack impressions.

A number of borrow pit sites were examined:
The **Lowlands borrow pit site** is a green fields site where soil cover largely obscures the bedrock (fig. 4 top). A number of test pits at this site have revealed a thick capping of geologically recent calcrete (fig. 4, top and middle). Some of these include shards of Beaufort Group sediments which probably underlie this capping. In support of this, sandy greenish mudstones where observed in an erosion channel cut into the slope which falls away to the west of the proposed borrow pit site (fig. 4, bottom).

Figure 4: Lowlands borrow pit site; *top*: proposed site with test pit in the foreground; *middle*: close up of exposed calcrete, *bottom*: greenish shale exposed to west of the site.

The locality indicated as that of the **Tarka Training Farm borrow pit site** was visited, though no markers, auger holes or test pits were observed. Although largely covered by recent soily alluvium, marginal outcrops indicate that this site is underlain by sedimentary strata (fig. 5 top). The remains of thin sandstone interbeds outcrop at surface. These include stone layers displaying water ripple impressions (fig.5 bottom)and others with fine mudchip clasts.

Figure 5: *top*: Site of proposed Tarka Training Farm borrow pit; *bottom* impressions of water ripples in thin sandstone.

The Tarka **Training Farm borrow pit site 2** is an extension of a large existing borrow pit from which decayed dolerite aggregate has been extracted (fig. 6). Auger holes within the floor of the existing excavation reveal the presence of dark green mudstones at a shallow depth below the remaining dolerite. As it would appear that the intention here is to extract weathered dolerite, it seems unlikely that the pit will be extended to impinge on these mudstones rather than being extended horizontally to extract further dolerite aggregate.

It is worth noting that this area is not mapped as doleritic on the geological map.

Figure 6: Tarka Training Farm 2 borrow pit: exposure of extensive dolerite sill in old workings.

The **Bontehoek borrow pit site** is situated across the road from older workings cut into a weathered dolerite sill (fig.7, bottom). Test pits in the new area indicate that this too is underlain by the same material though somewhat calcretised near surface (fig.7, top).

Figure 7: Bontehoek borrow pit: *top*: proposed site of new borrow pit showing calcretised rotten dolerite exposed by a test pit; *bottom*: dolerite exposed in old borrow pit adjacent to new site.

IMPACTS IDENTIFIED AND ASSESSED

The proposed development will inevitably result in the destruction of potentially palaeontologically significant strata during the road works, both by the cutting back of roadcuttings and the development of borrow pits, as is detailed in the section below.

Construction Phase

Impact 1: Cutting back of roadcuttings

Cause and Comment This is not particularly significant as only one small roadcutting will be affected, which was not found to be fossiliferous on inspection, though fossils could be contained in the material to be cut away

Mitigation and management
Mitigation is probably not warranted in this case.

Significance statement

Due to the nature of palaeontological resources the standard impact rating system used in this study is not entirely appropriate.

According to this system it can be stated that any loss of palaeontological material would be **permanent**. If this material happened to be important its loss would be **very severe** and of **international** affect. However in this case it would be very **unlikely**.

Impact 2: Development of Lowlands and Tarka Training Farm borrow pits

Cause and Comment the excavation of large borrow pits into previously uninvestigated, potentially fossiliferous strata within a few kilometres of known significant fossil discoveries opens the strong possibility that palaeontological material may be destroyed

Mitigation and management

Without mitigation: Without mitigation this could contribute to the steady destruction of unique palaeontological heritage.

With mitigation: With mitigation this could lead to important new discoveries.

Significance statement
Due to the nature of palaeontological resources the standard impact rating system used in this study is not entirely appropriate.

According to this system it can be stated that any loss of palaeontological material would be **permanent**. If this material happened to be important its loss would be **very severe** and of **international** affect. In this case it would be **possible**.

Any material recovered through mitigation would for practical purposes represent a **permanent beneficial** gain of potentially **international** significance. This is **possible**.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the construction of the road itself will have a very low chance of impacting on palaeontological resources and this only in a very limited area. No mitigation will therefore be required before, during or after the envisioned cutting.

There is however a reasonable chance that palaeontological material in the form of **vertebrate fossils will be exposed during development of the Lowlands and Tarka Training Farm borrowpits** as these are situated within a few kilometres of significant previous finds. It is therefore recommended that if these sites are utilised mitigation should be undertaken. This should include **a meeting between a palaeontologist, the EO and the foreman, shortly after the sites have been opened**, in order to explain to them what to look out for and to have an initial inspection. Secondly **these two borrow pits should be examined for fossils at the end of aggregate extraction**, prior to rehabilitation.

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