

PALAEONTOLOGICAL IMPACT ASSESSMENT REPORT

THE PROPOSED UTILISATION OF BORROW PITS ON ROADS:

**ANDM-IR01 – Matatiele Local Municipality
in the ALFRED NZO DISTRICT MUNICIPALITY**

**DR07357 & DR07460 – Lukhanji Local Municipality
DR08599, DR08600 & DR08602 – Emalahleni Local Municipality
R344-CHDM-IP01 – Tsolwana Local Municipality
in the CHRIS HANI DISTRICT MUNICIPALITY**

**ORTDM-IR03 – Nyandeni Local Municipality
ORTDM-IR01 & ORTDM-IR02 – Ingquza Hill Local Municipality
ORTDM-IR04 – Ntabankulu Local Municipality
in the O R TAMBO DISTRICT MUNICIPALITY**

**DR01763 & MR00397 – Kouga Local Municipality
DR01776 – Kou-Kamma Local Municipality
in the CACADU DISTRICT MUNICIPALITY**

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EXECUTIVE SUMMARY

The Department of Roads and Public Works of the Eastern Cape Province identified 28 borrow pits in order to obtain construction materials as part of a larger project to upgrade/re-surface a total of 14 roads located in the Alfred Nzo- , Chris Hani- , OR Tambo- and Cacadu District Municipalities. Biotechnology & Environmental Specialist Consultancy (BESC) commissioned this Palaeontological Impact Assessment as part of the Heritage Impact Assessment. The purpose of the Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

The proposed project is planned to utilise road building material from the new and existing borrow pits to upgrade the following sections of roads: i) DR01763, MR00397 & DR01776 in the Cacadu District Municipality; ii) DR08599, DR08600, DR08602, R344-CHDM-IR01, DR7357 & DR&S60 in the Chris Hani District Municipality; iii) ORTDM-IR01, ORTDM-IR02, ORTDM-IR03 & ORTDM-IR04 in the OR Tambo District Municipality; and iv) ANDM-IR01 at the Alfred Nzo District Municipality.

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000) maps in conjunction with Google Earth. A review of the literature on the geological formations exposed at surface in the development site and the fossils that have been associated with these geological strata was undertaken. A site field investigation was conducted on 14 – 19 November 2011, with the aim to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The study area is underlain rocks ranging in age from the Ordovician (Table Mountain Group) to Permian and Triassic Adelaide and Tarkastad Subgroups of the Beaufort Group of the Karoo Supergroup. Dolerite intrusions of the Jurassic era are present over the entire study area. Alluvial deposits of the Quaternary era occur predominantly in the lower lying valley floors. The underlying sequences of the Table Mountain Group, overlain by the Bokkeveld Group, the Dwyka Formation have low fossil occurrence if any. The upper Ecca Group followed by the Beaufort Group is known for fossil occurrence in the biostratigraphic subdivision of the group.

The field investigation confirms that the borrow pit sites are dominated by rolling hill topography. The results of the field invitation were that the borrow pits associated with the (i) undifferentiated, sequence of mudrock and siltstone units of the Ceres Formation were deeply weathered and no fossils were found, however the possibility of finding fossils during future excavation operations is high (ii) undifferentiated mudrock, carbonaceous shales, fine-grained graywackes and alternating dark-grey shales of the Ecca Group were deeply weathered and fossils were restricted to poorly defined trace fossils, (ii).the Tarkastad Subgroup revealed highly weathered leave fossils and although no complete body fossils were discovered during the field investigations, the possibility of finding fossils during future excavation operations is very high (a few bone fragments were recorded), (iii) predominantly red mudstone in the Burgersdorp Formation of the Tarkastad Subgroup

revealed a few bone fragments and trace fossils, confirming the possibility of finding fossils during future excavation operations is and (iv) igneous rock of the Karoo Dolerite does not contain fossils

Borrow pits within the Ceres Formation of the Bokkeveld Group and the Ecca Group has a medium palaeontological sensitivity rating. The borrow pits within the Beaufort Group i.e. Tarkastad Subgroup as well as the identified Burgersdorp Formations of the Tarkastad Subgroup have a high palaeontological sensitivity rating. The significance rating can be summarised as follows:

Rock Unit	Temporal Scale (duration of impact)	Spatial Scale (area in which impact will have an effect)	Degree of confidence (confidence with which one has predicted the significance of an impact)	Impact severity (severity of negative impacts, or how beneficial positive impacts would be)		Overall Significance (The combination of all the other criteria as an overall significance)	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Ceres Subgroup	permanent	international	possible	beneficial	severe	beneficial	Negative
Ecca Group	permanent	international	possible	beneficial	severe	beneficial	Negative
Tarkastad Subgroup	permanent	international	possible	beneficial	very severe	beneficial	High negative
Burgersdorp Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative

Through adequate monitoring and mitigation measures during excavations, the high impact severity can be lowered to beneficial. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) will be a beneficial palaeontological impact.

It is recommended: (i) That a collection and rescue permit be obtained from SAHRA prior construction. (ii) That all earth-moving activities within the borrow pits with potential impact on the Ceres Formation, the Ecca Group, the Tarkastad Subgroup and the Burgersdorp Formations of the Tarkastad Subgroup be monitored by a palaeontologist. (iii) That a monitoring report be submitted to SAHRA after the completion of the earth works phase. (iv) That the resident ECO be trained by a professional palaeontologist in the recognition of fossil material. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof.

Road and borrow pit specific mitigation recommendation is summarised as follows:

Rd No	B/Pit No	Mitigation Measures
Cacadu District Municipality		
DR01763	1763_BP01	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR01763	1763_BP02	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
MR00397	397_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR01776	DR01776_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
Chris Hani District Municipality		
DR08599	08599_BP01	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08599	08599_BP02	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR08600	08600_BP01	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08602	08602_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR08602	08602_BP02	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR08602	08602_BP04	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
R344 –CHDM-IR01	R344 –CHDM-IR01_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
R344 – CHDM-IR01	R344 – CHDM-IR01_BP02	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
R344 – CHDM-IR01	R344 –CHDM-IR01_BP03	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR07357	07357_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR07460	07460_BP02	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.

Rd No	B/Pit No	Mitigation Measures
OR Tambo District Municipality		
ORTDM-IR01	ORTDM-IR01_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
ORTDM-IR02	ORTDM-IR02_BP01	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR02	ORTDM-IR02_BP02	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR03	ORTDM-IR03_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
ORTDM-IR04	ORTDM-IR04_BP01	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
ORTDM-IR04	ORTDM-IR04_BP02	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR04	ORTDM-IR04_BP03	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR04	ORTDM-IR04_BP04	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
Alfred Nzo District Municipality		
ANDM-IR01	ANDM-IR01_BP01	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
ANDM-IR01	ANDM-IR01_BP02	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
ANDM-IR01	ANDM-IR01_BP03	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ANDM-IR01	ANDM-IR01_BP04	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ANDM-IR01	ANDM-IR01_BP05	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.

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1. INTRODUCTION

The Department of Roads and Public Works of the Eastern Cape Province identified 28 borrow pits in order to obtain construction materials as part of a larger project to upgrade/re-surface a total of 14 roads located in the Alfred Nzo- (1 road), Chris Hani- (6 roads), OR Tambo (4 roads) and Cacadu (3 roads) District Municipalities. Biotechnology & Environmental Specialist Consultancy (BESC) commissioned this Palaeontological Impact Assessment as part of the Heritage Impact Assessment. The purpose of the Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

1.1. Legal Requirements

This report forms part of the preparation of an Environmental Management Plan as defined and required by Regulations in terms of the Minerals and Petroleum Resources Development Act 28 of 2002 for the permitting of borrow pits. The report also complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the footprint of the identified 28 borrow pits.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

2. PROPOSED DEVELOPMENT DESCRIPTION

The Eastern Cape Province's Department of Roads and Public Works identified 28 borrow pits in order to obtain construction materials as part of a larger project to upgrade/re-surface a total of 14 roads. The roads and borrow pits identified is summarised in Table 2.1. For the location of the borrow pits see Figures 2.1 to 2.4.

Table 2.1 Roads and borrow-pits investigated at each District Municipality

Rd No	B/Pit No	Latitude (S)	Longitude (E)	Area	Municipality
Cacadu District Municipality					
DR01763	1763_BP01	34° 6'9.57"	24°43'10.00"	Humansdorp	Kouga LM
DR01763	1763_BP02	34° 7'50.20"	24°42'48.00"	Humansdorp	Kouga LM
MR00397	397_BP01	33°51'56.80"	24°45'1.00"	Humansdorp	Kouga LM
DR01776	DR01776_BP01	34° 4'21.40"	24°20'39.20"	Humansdorp	Kou-Kamma LM
Chris Hani District Municipality					
DR08599	08599_BP01	31°38'21.40"	27°24'32.60"	Lady Frere	Emalahleni Lm
DR08599	08599_BP02	31°40'19.80"	27°22'48.00"	Lady Frere	Emalahleni LM
DR08600	08600_BP01	31°44'7.90"	27°20'28.70"	Lady Frere	Emalahleni LM
DR08602	08602_BP01	31°40'28.30"	27°23'46.20"	Lady Frere	Emalahleni LM

Rd No	B/Pit No	Latitude (S)	Longitude (E)	Area	Municipality
DR08602	08602_BP02	31°41'59.30"	27°24'46.60"	Lady Frere	Emalahleni LM
DR08602	08602_BP04	31°42'42.40"	27°23'49.40"	Lady Frere	Emalahleni LM
R344 -CHDM-IR01	R344 -CHDM-IR01_BP01	32°18'24.15"	26°18'9.70"	Tarkastad	Tsolwana LM
R344 - CHDM-IR01	R344 - CHDM-IR01_BP02	32°18'46.90"	26°19'28.00"	Tarkastad	Tsolwana LM
R344 - CHDM-IR01	R344 -CHDM-IR01_BP03	32°19'31.70"	26°19'54.40"	Tarkastad	Tsolwana LM
DR07357	07357_BP01	32°19'34.00"	26°39'17.20"	Whittlesea	Lukhanji LM
DR07460	07460_BP02	32° 4'30.90"	26°35'4.00"	Whittlesea	Lukhanji LM
OR Tambo District Municipality					
ORTDM-IR01	ORTDM-IR01_BP01	31°15'48.65"	29°33'20.67"	Lusikisiki	Ingquza Hill LM
ORTDM-IR02	ORTDM-IR02_BP01	31°16'25.30"	29°29'13.40"	Lusikisiki	Ingquza Hill LM
ORTDM-IR02	ORTDM-IR02_BP02	31°15'37.20"	29°29'7.10"	Lusikisiki	Ingquza Hill LM
ORTDM-IR03	ORTDM-IR03_BP01	31°21'24.30"	29° 6'8.50"	Libode	Nyandeni LM
ORTDM-IR04	ORTDM-IR04_BP01	30°46'13.6"	29°31'41.3"	Mount Ayliff	Ntabankulu LM
ORTDM-IR04	ORTDM-IR04_BP02	30°46'23.30"	29°30'38.70"	Mount Ayliff	Ntabankulu LM
ORTDM-IR04	ORTDM-IR04_BP03	30°46'31.13"	29°29'48.71"	Mount Ayliff	Ntabankulu LM
ORTDM-IR04	ORTDM-IR04_BP04	30°46'48.00"	29°29'34.40"	Mount Ayliff	Ntabankulu LM
Alfred Nzo District Municipality					
ANDM-IR01	ANDM-IR01_BP01	30°25'54.90"	29° 3'30.80"	Cedarville	Matatiele LM
ANDM-IR01	ANDM-IR01_BP02	30°32'0.86"	29° 4'3.37"	Cedarville	Matatiele LM
ANDM-IR01	ANDM-IR01_BP03	30°34'28.50"	29° 3'20.80"	Cedarville	Matatiele LM
ANDM-IR01	ANDM-IR01_BP04	30°33'39.60"	29° 2'14.20"	Cedarville	Matatiele LM
ANDM-IR01	ANDM-IR01_BP05	30°33'16.06"	29° 1'26.59"	Cedarville	Matatiele LM

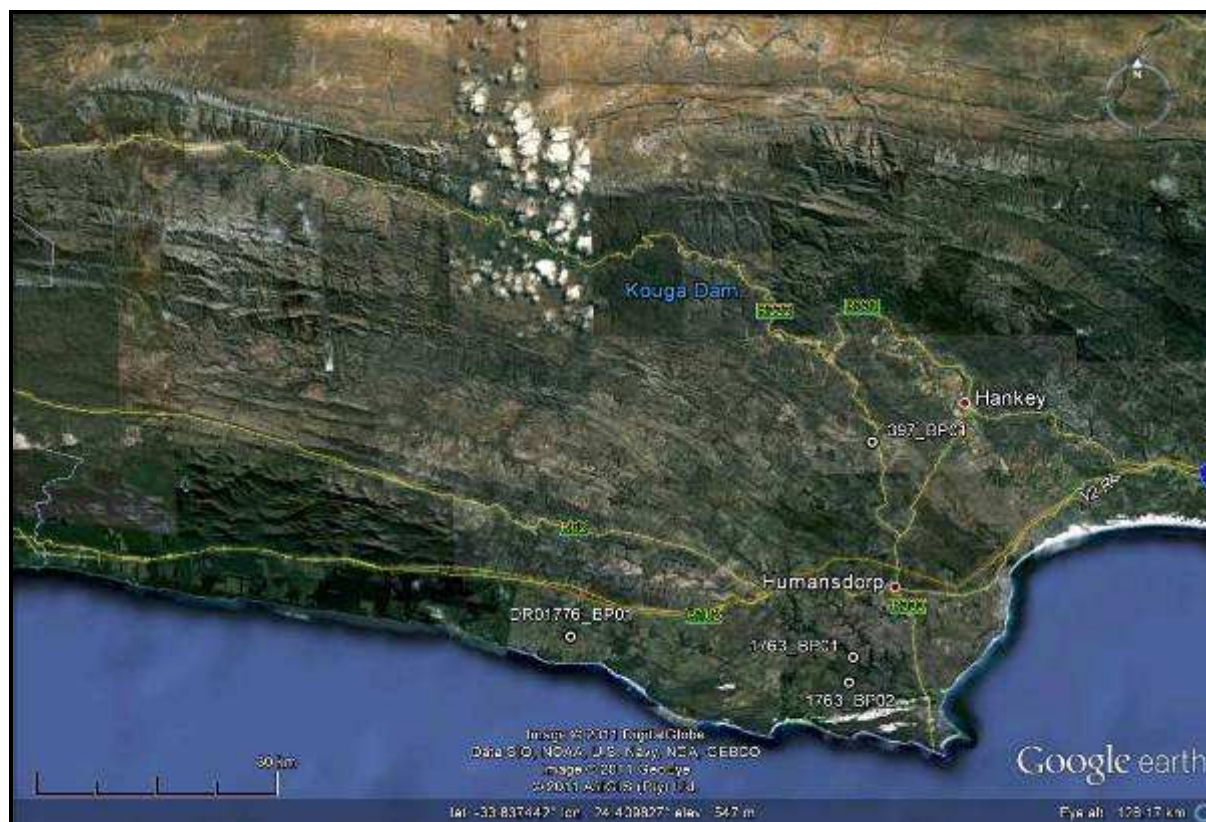


Figure 2.1 Location of the Cacadu District Municipality identified borrow pits



Figure 2.2 Location of the Chris Hani District Municipality identified borrow pits

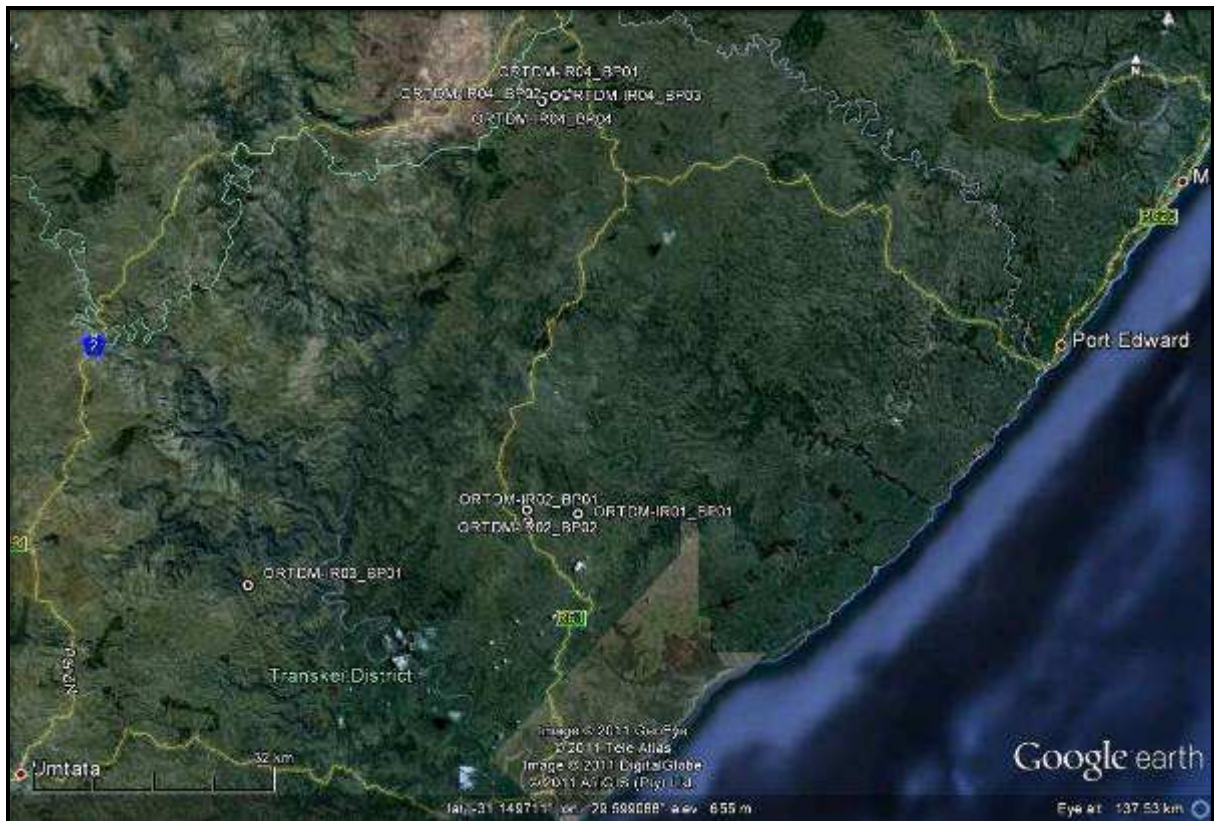


Figure 2.3 Location of the OR Tambo District Municipality identified borrow pits

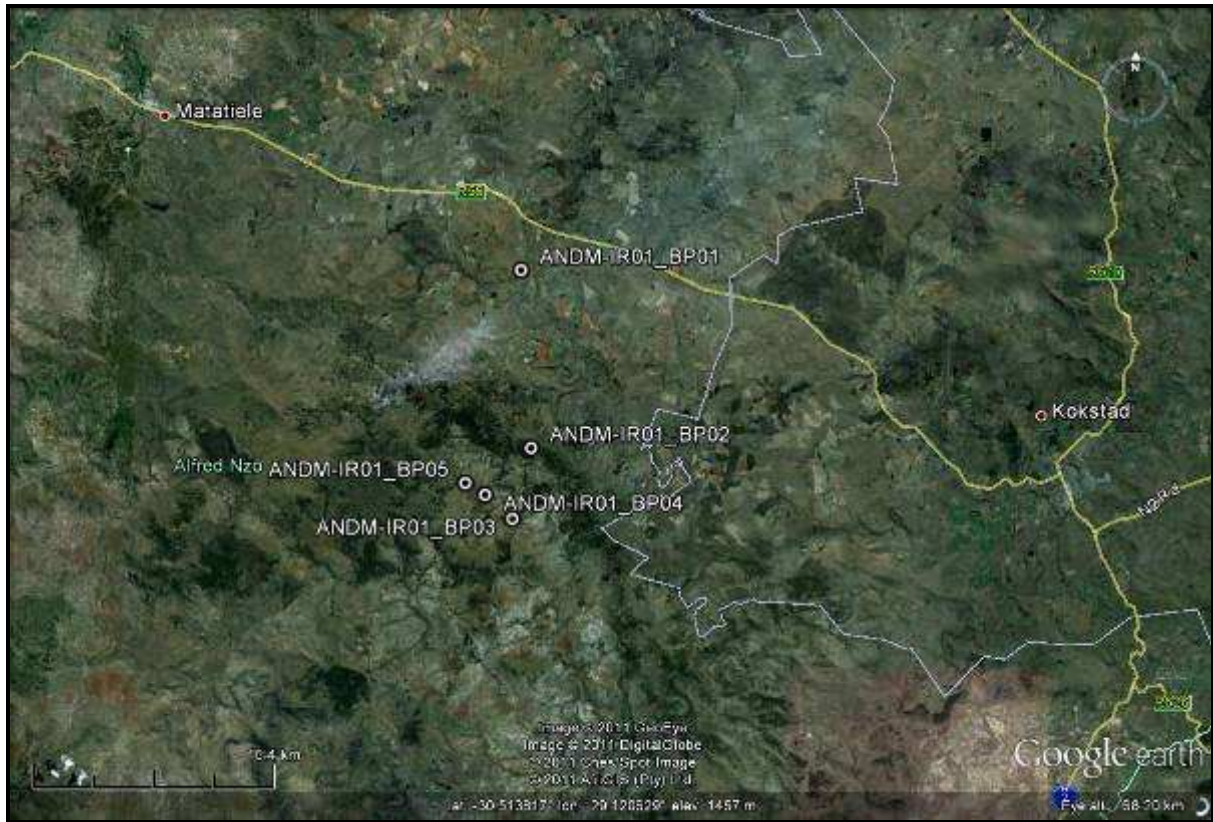


Figure 2.4 Location of the Alfred Nzo District Municipality identified borrow pits

3. AIMS AND METHODS

After discussions with BESC a request for a Phase 1 Palaeontological Impact Assessment (PIA) was received. Following the *“SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports”* the aims of the PIA were:

- identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- assessing the level of palaeontological significance of these formations;
- conducting fieldwork to assess the immediate risk to exposed fossils as well as to document and sample these localities;
- commenting on the impact of the development on these exposed and/or potential fossil resources;
- making recommendations as to how the developer should conserve or mitigate damage to these resources.

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000) maps in conjunction with Google Earth. The only limitation on this methodology is the scale of mapping, which restricts comparison of the geology to the 1:250 000 scale. This restriction only applies in areas where major changes in the geological character of the area occur over very short distances or on the geological transformation zones.

A review of the literature on the geological formations exposed at surface in the development site and the fossils that have been associated with these geological strata was undertaken.

A field investigation of the site was conducted on 14-18 November 2011 by Dr G Groenewald and Mrs S Groenewald who are experienced fieldworkers. The aims of the fieldwork were to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

4. GEOLOGICAL BACKGROUND OF THE AREA

The study area is underlain rocks ranging in age from the Ordovician (Table Mountain Group) to Permian and Triassic Adelaide and Tarkastad Subgroups of the Beaufort Group of the Karoo Supergroup. Dolerite intrusions of the Jurassic era are present over the entire study area. Alluvial deposits of the Quaternary era occur predominantly in the lower lying valley floors.

The entire sequence consists of the Table Mountain Group, overlain by the Bokkeveld Group, the Dwyka Formation, the Eccca Group, Beaufort Group, Alluvium deposits and intrusive Karoo dolerite. The various borrow pits' geology identified and verified is summarised in Table 4.1 and illustrated in Figures 4.1 – 4.5.

Table 4.1 The geology of the various borrow pits

Rd Nr	B/Pit No	Geology	Area	Figure
DR01763	1763_BP02	Goudini Formation (Sg)	Humansdorp	4.1
MR00397	397_BP01	Goudini Formation (Sg)	Humansdorp	4.1
DR01776	DR01776_BP01	Goudini Formation (Sg)	Humansdorp	4.1
DR01763	1763_BP01	Ceres Formation (Dc)	Humansdorp	4.1
ORTDM-IR02	ORTDM-IR02_BP01	Eccca Group (Pe)	Lusikisiki	4.4
ORTDM-IR02	ORTDM-IR02_BP02	Eccca Group (Pe)	Lusikisiki	4.4
ORTDM-IR04	ORTDM-IR04_BP01	Eccca (Pe) & Dolerite (Jd)	Mount Ayliff	4.4
ORTDM-IR04	ORTDM-IR04_BP02	Eccca Group (Pe)	Mount Ayliff	4.4
ORTDM-IR04	ORTDM-IR04_BP03	Eccca Group (Pe)	Mount Ayliff	4.4
ORTDM-IR04	ORTDM-IR04_BP04	Eccca Group (Pe) & Dolerite (Jd)	Mount Ayliff	4.4
ANDM-IR01	ANDM-IR01_BP01	Tarkastad Subgroup (Trt)	Cedarville	4.5
ANDM-IR01	ANDM-IR01_BP02	Tarkastad Subgroup (Trt)	Cedarville	4.5
ANDM-IR01	ANDM-IR01_BP03	Tarkastad (Trt) & Dolerite (Jd)	Cedarville	4.5
ANDM-IR01	ANDM-IR01_BP04	Tarkastad (Trt) & Dolerite (Jd)	Cedarville	4.5
DR07460	07460_BP02	Burgersdorp Formation (Trb)	Whittlesea	4.2
DR08599	08599_BP01	Burgersdorp (Trb) & Dolerite (Jd)	Lady Frere	4.3
DR08600	08600_BP01	Burgersdorp (Trb) & Dolerite (Jd)	Lady Frere	4.3
DR08602	08602_BP04	Burgersdorp (Trb) & Dolerite (Jd)	Lady Frere	4.3
DR07357	07357_BP01	Dolerite (Jd)	Whittlesea	4.2
DR08599	08599_BP02	Dolerite (Jd)	Lady Frere	4.3
DR08602	08602_BP01	Dolerite (Jd)	Lady Frere	4.3
DR08602	08602_BP02	Dolerite (Jd)	Lady Frere	4.3
ANDM-IR01	ANDM-IR01_BP05	Dolerite (Jd)	Cedarville	4.5
ORTDM-IR01	ORTDM-IR01_BP01	Dolerite (Jd)	Lusikisiki	4.4
ORTDM-IR03	ORTDM-IR03_BP01	Dolerite (Jd)	Libode	4.4
R344 - CHDM-IR01	R344 - CHDM-IR01_BP02	Dolerite (Jd)	Tarkastad	4.2
R344 - CHDM-IR01	R344 - CHDM-IR01_BP01	Dolerite (Jd)	Tarkastad	4.2
R344 - CHDM-IR01	R344 - CHDM-IR01_BP03	Dolerite (Jd)	Tarkastad	4.2

The borrow pits' geological units identified can be summarised as follows:

4.1. The Table Mountain Group

The Table Mountain Group of rocks consists of reddish-grey conglomerates, cross-bedded siliceous quartzose and feldspathic sandstone and mudstones. The age of the Group is tentatively placed in the Ordovician to Devonian epoch (Marshall 2006, in Johnson et al, 2006).

4.1.1. The Goudini Formation

The Goudini Formation is red-brown sandstone, interpreted shallow marine fluvial braid plain deposit (Johnson et al 2006)

4.2. The Bokkeveld Group

The Bokkeveld Group consists of a cyclic alteration of fine-grained sandstone and mudstone units that conformably overlie the Table Mountain Group.

4.2.1. Ceres Subgroup

In the study area the Ceres Subgroup is undifferentiated, comprising a sequence mudrock and siltstone units which interpreted as the depositional products of offshore shelf and prodelta slope environments (Johnson et al., 2006).

4.3. Ecca Group

The Ecca Group is a succession of shale and subordinate sandstone, conformably overlying the Dwyka tillites. In the study area the Ecca Group consists of undifferentiated mudrock, carbonaceous shales, fine-grained graywackes and alternating dark-grey shales. Due to extensive faulting and deep weathering the Ecca Group rocks have not been studied in detail.

4.4. The Beaufort Group

The Beaufort Group is made up of the lower Adelaide and upper Tarkastad Subgroups, of which only the Tarkastad Subgroup is applicable in this study.

4.4.1. The Tarkastad Subgroup

The Tarkastad Subgroup is made up of the lower arenaceous Katberg Formation and the upper argillaceous Burgersdorp Formation. Based on the characteristic presence of upward-fining cycles, lenticular sandstones, massive mudstones and non-marine vertebrate remains, the depositional history of the Tarkastad Subgroup is also interpreted as a fluvial environment.

4.4.1.1. Burgersdorp Formation

The Burgersdorp Formation consists of a succession of predominantly red mudstone and interbedded yellow-grey to light greenish-grey sandstone. The depositional environment is interpreted to be predominantly fluvial with extensive lacustrine deposits associated with this sequence (Groenewald, 1996; Johnson et al 2006).

4.5. Karoo Dolerite

Karoo Dolerite intrusions are present over the entire study area. Due to its resistance to weathering, it underlies most of the higher topography in the region.

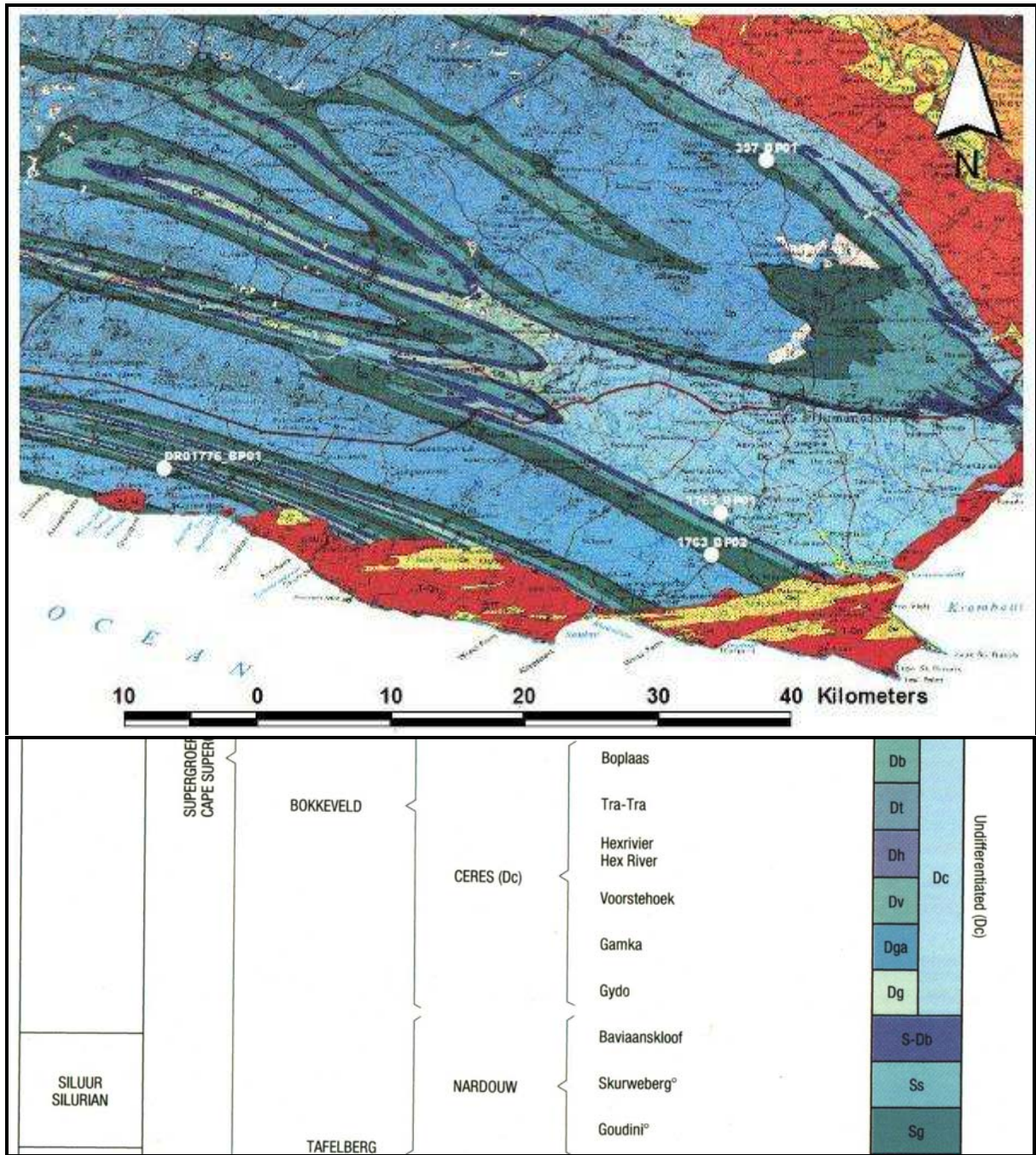


Figure 4.1 The geology of borrow pits in the Cacadu District Municipality (Map 3324 Port Elizabeth)

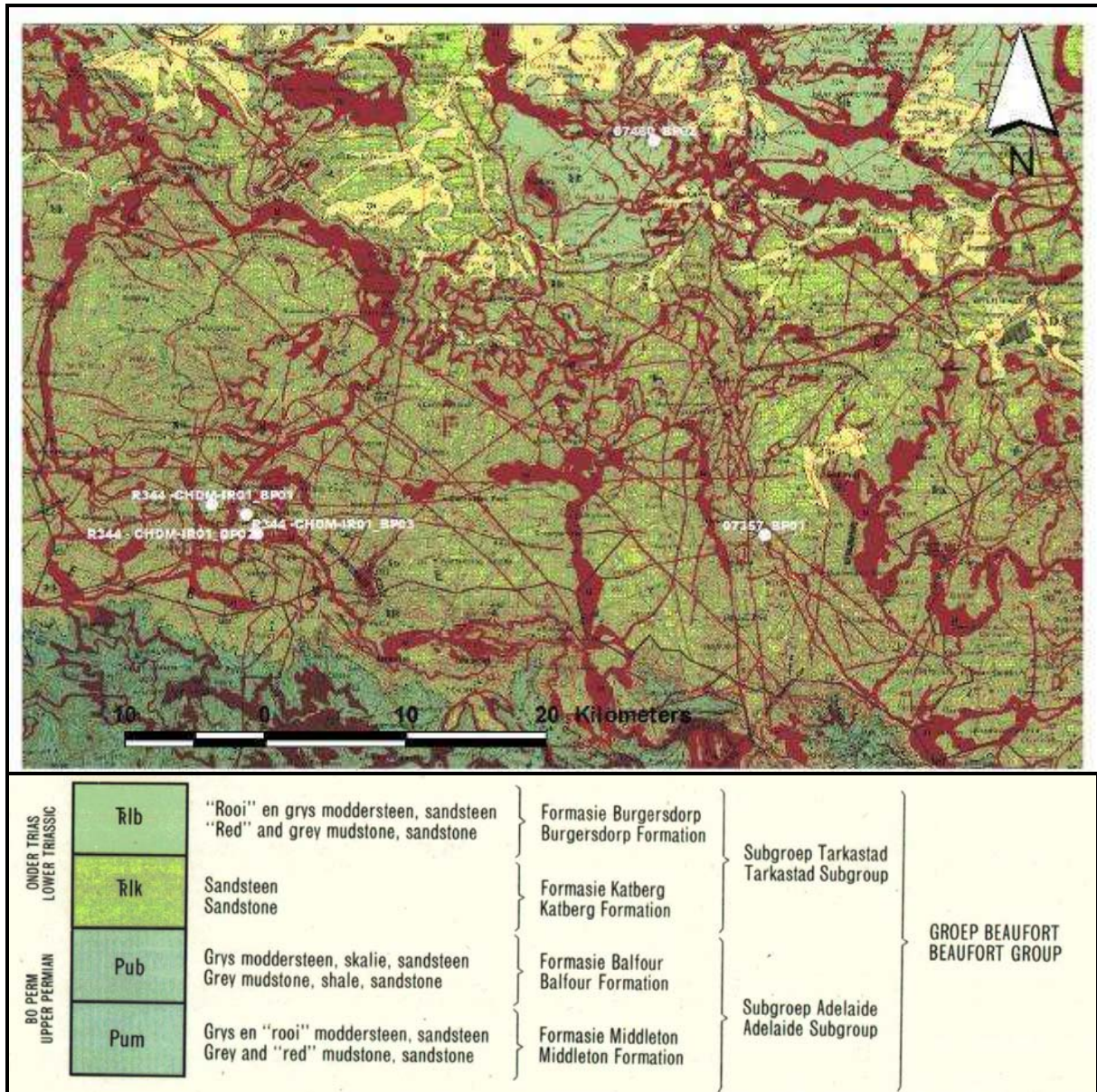


Figure 4.2 The geology of borrow pits in the southern part of the Chris Hani District Municipality (Map 3226 King William's Town)

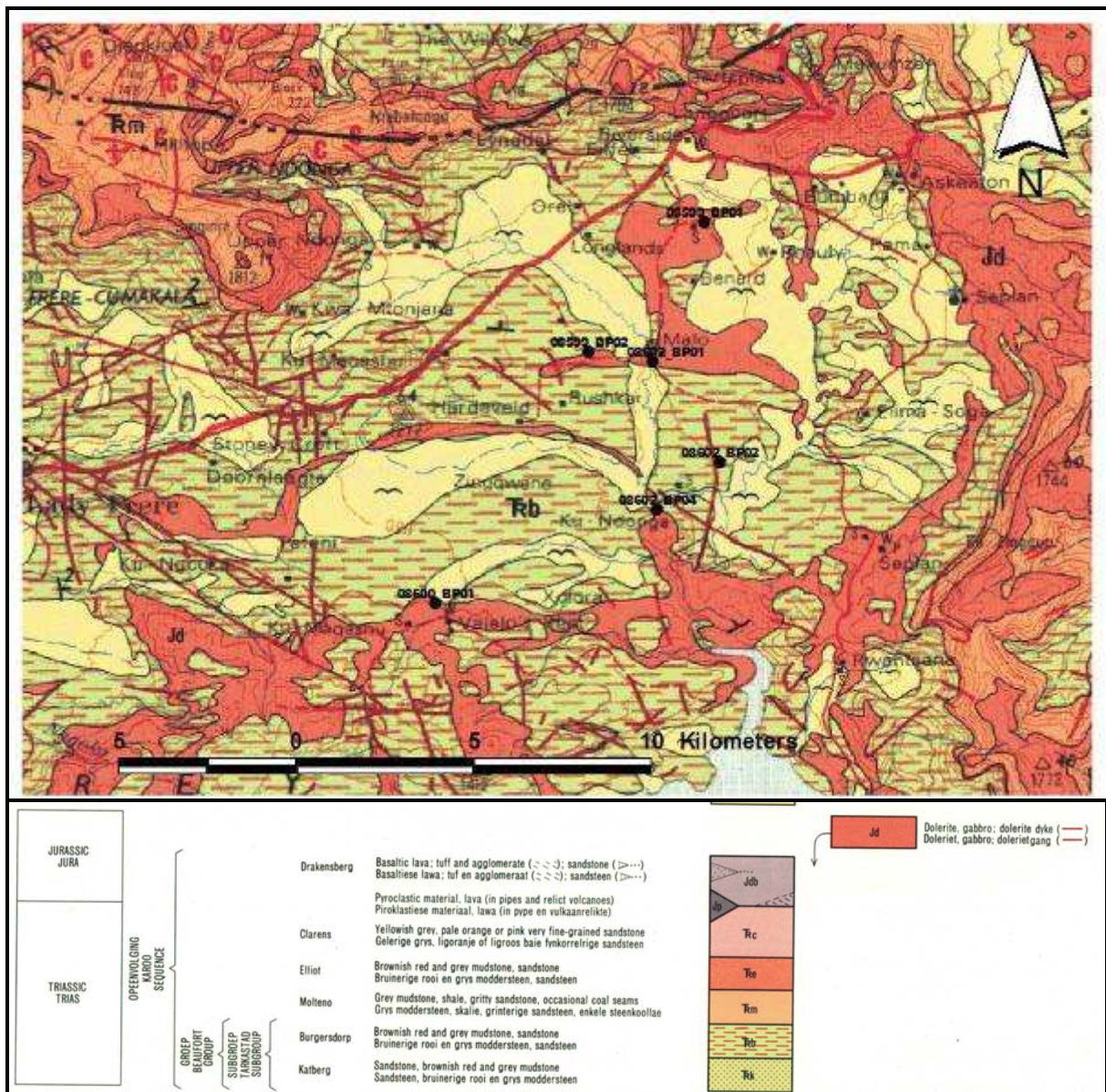


Figure 4.3 The geology of borrow pits in the northern part of the Chris Hani District Municipality (Map 3126 Queenstown)

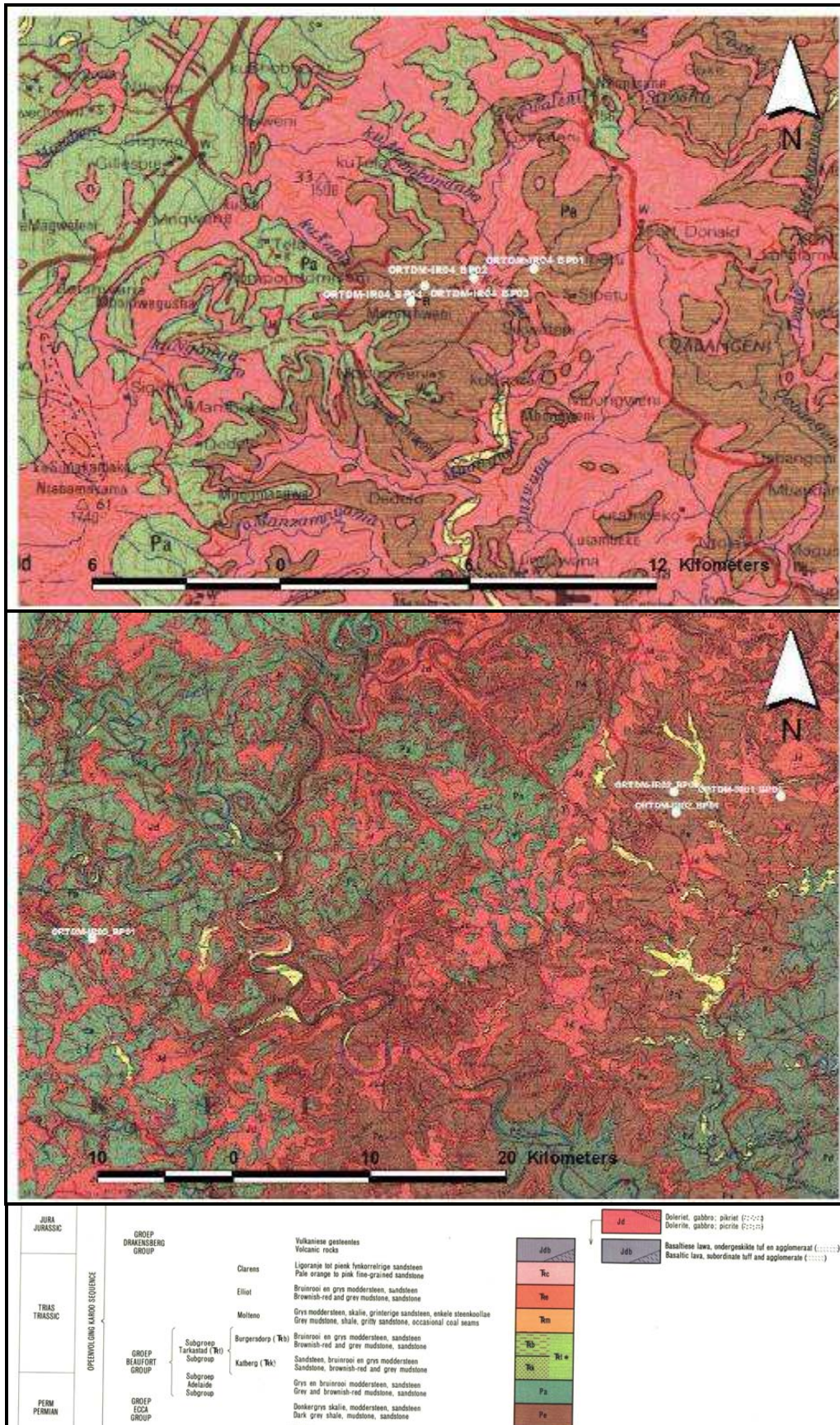


Figure 4.4 The geology of borrow pits in the OR Tambo District Municipality (Maps 3028 Kokstad and 3128 Umtata)

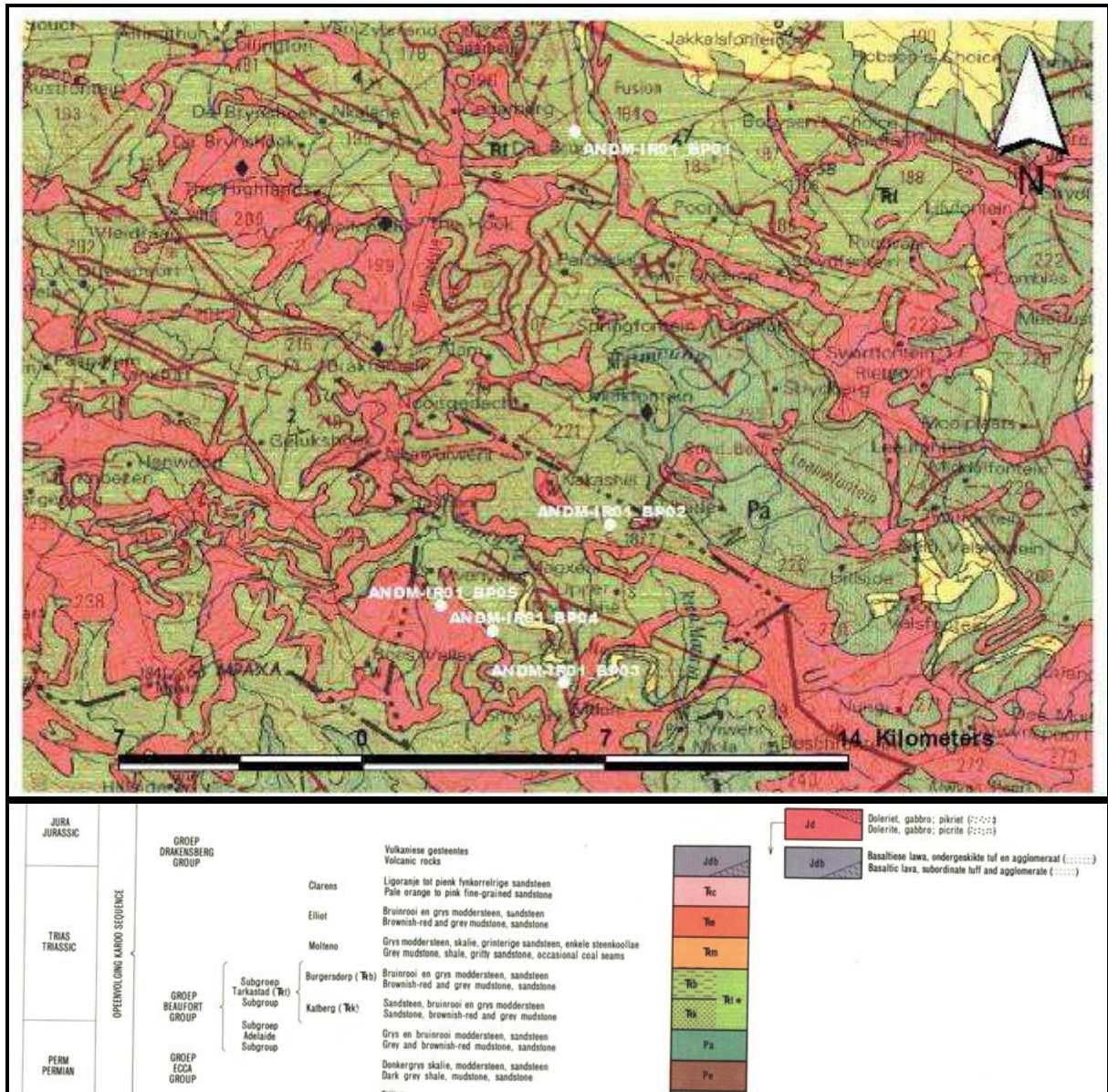


Figure 4.5 The geology of borrow pits in the Alfred Nzo District Municipality (Map 3028 Kokstad)

5. PALAEOLOGICAL BACKGROUND OF THE AREA

The underlying sequences of the Natal Group, overlain by the Dwyka Formation and the Ecca Group have low fossil occurrence if any. The upper Beaufort Group is known for fossil occurrence in the biostratigraphic subdivision of the group.

5.1. The Table Mountain Group

The Table Mountain Group is known for the rich assemblages of trace fossils that is occurs in the sandstone.

5.1.1. The Goudini Formation

No specific fossils are described from the Goudini Formation, but the depositional environment is interpreted as shallow marine, with longshore currents being the main mode of sediment transport (Johnson et al. 2006)

5.2. The Bokkeveld Group

5.2.1. The Ceres Subgroup

The Ceres Subgroup is known to contain abundant marine benthic invertebrate fossils, including brachiopods, bivalves, trilobites, cephalopods, crinoids, ophiuroids, hyoliths, crinoid stems, corals and gastropods (Johnson et al, 2006).

5.3. The Ecca Group

The Ecca Group rocks are in general deeply weathered and fossils are restricted to poorly defined trace fossils.

5.4. Beaufort Group

The value of vertebrate fossils in rocks of the Beaufort Group lies in its use as distinguishable biostratigraphic criteria to refine further subdivision of the group. The biozones employed are based on the vertebrate fossil remains that are so abundant in these rocks.

Excavations for the burrow pits, as well as the roads and other infrastructure, may provide an opportunity to inspect fresh unweathered rock of this assemblage zone in the study area.

5.4.2. Tarkastad Subgroup

5.4.2.1. Burgersdorp Formation

The Burgersdorp Formation is associated with the *Cynognathus* Assemblage Zone which is known as a productive fossil bearing zone in the Karoo Supergroup (Rubidge et al 1995; Groenewald 1996; Johnson et al, 2006).

5.5. Karoo Dolerite

Due to the igneous character of this rock type it does not contain fossils.

6. RESULTS OF THE FIELD INVESTIGATION

The development area is dominated by rolling hill topography with poor outcrops of all the rock formations. The results of the field investigations in the various geological units are as follows:

6.1. Table Mountain Group

6.1.1. Goudini Formation

No fossils are expected from the Goudini Formation and no indication of trace fossils were found during the field investigation.

6.2. The Bokkeveld Group

6.2.1. Ceres Subgroup

No fossils were observed in the outcrops of the Ceres Subgroup, but the subgroup is known to contain well preserved fossils and the absence of fossils should not be seen as an indication that fossils will not be found during further excavation of the burrow pit.

6.3. Ecca Group

Outcrops of the Ecca Group are restricted to deeply excavated quarries and fossils are restricted to trace fossils

6.4. Beaufort Group

6.4.2. Tarkastad Subgroup

Quarries excavated into highly weathered mud rock of the Tarkastad Subgroup and some examples of trace fossils and small bone fragments are present in these outcrops.

6.4.2.1. Burgersdorp Formation



Borrow pits associated with the Burgersdorp Formation did not reveal any body fossils and trace fossils are restricted to some poorly defined burrow casts.







6.5. Karoo Dolerite







Karoo Dolerite is an igneous rock and does not contain fossils








The results of the field investigation are summarised according to the various roads in Table 6.1

Table 6.1 Field investigation results for each Municipality



Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
Cacadu District Municipality				
DR01763	1763_BP01	Dc		
DR01763	1763_BP02	Sg		

Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
MR00397	397_BP01	Sg		
DR01776	DR01776_BP01	Sg		
Chris Hani District Municipality				
DR08599	08599_BP01	Trb & Jd		
DR08599	08599_BP02	Jd		
DR08600	08600_BP01	Trb & Jd		
DR08602	08602_BP01	Jd		

Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
DR08602	08602_BP02	Jd		
DR08602	08602_BP04	Trb & Jd		
R344-CHDM IR01	R344_BP01	Jd		
R344-CHDM IR01	R344_BP02	Jd		
R344-CHDM IR01	R344_BP03	Jd		
DR07357	07357_BP01	Jd		

Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
DR07460	07460_BP02	Trb		
OR Tambo District Municipality				
ORTDM-IR01	IR01_BP01	Jd		
ORTDM-IR02	IR02_BP01	Pe		
ORTDM-IR02	R02_BP02	Pe		
ORTDM-IR03	IR03_BP01	Jd		
ORTDM-IR04	IR04_BP01	Pe & Jd		

Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
ORTDM-IR04	IR04_BP02	Pe		
ORTDM-IR04	IR04_BP03	Pe		
ORTDM-IR04	IR04_BP04	Pe & Jd		
Alfred Nzo District Municipality				
ANDM-IR01	IR01_BP01	Trt		
ANDM-IR01	IR01_BP02	Trt		
ANDM-IR01	IR01_BP03	Trt & Jd		

Rd Nr	B/Pit No	Geology	Site Photo	Fossil Photo(s) if any
ANDM-IR01	IR01_BP04	Trt & Jd		
ANDM-IR01	IR01_BP05	Jd		

7. PALAEOLOGICAL SIGNIFICANCE AND RATING

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews, as well as information gathered during the field investigation.

The palaeontological significance and rating is summarised in Table 7.1 and 7.2. For the methodology and definitions of impact rating and significance see Appendix A (CES 2011).

There is a possibility that fossils could be encountered during excavation in to the Bokkeveld, Ecca and Beaufort Group geology and these fossils would be of international significance. If effective mitigation is in place at the time of exposure, and the fossils are successfully excavated for study, this would represent a beneficial palaeontological impact.

Table 7.1 Palaeontological Significance of Geological Units of the Borrow pits

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Goudini Formation	Red-brown sandstone, interpreted shallow marine fluvial braid plain deposits; ORDOVICIAN/ SILURIAN	Poor; no diagnostic fossils	None	Nil
Ceres Subgroup	Cyclic alteration of fine-grained sandstone and mudstone units DEVONIAN	Abundant marine benthic invertebrate fossils, including brachiopods, bivalves, trilobites, cephalopods, crinoids, ophiuroids, hyoliths, cricoconarids, corals and gastropods		Medium sensitivity

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Ecca Group	Marine shales and sandstones; PERMIAN	<i>Mesosaurid</i> reptiles, crustaceans, palaeoniscoid fish, rare ichnofossils plants, sponge spicules, insect wings		Medium sensitivity
Tarkastad Subgroup	Upward-fining cycles of lenticular sandstones and massive mudstones EARLY TRIASSIC	Vertebrate fossils also include amphibians	<i>Lystrosaurus</i> and <i>Cynognathus</i> Assemblage Zone	High sensitivity
Burgersdorp Formation	Fluvial and lacustrine mudstones and sandstones. EARLY TRIASSIC	Vertebrate fossils also include amphibians	<i>Cynognathus</i> Assemblage Zone	High sensitivity
Drakensberg Group	Dolerite Dykes & Sills (Igneous Intrusions) JURASSIC	None	None	Nil

Unfortunately within these rock units there is no way of assessing the likelihood of encountering fossils during excavation. As evidenced in other similar areas with exposures, fossils were apparently absent or very scarce over large areas, but locally dense accumulations were found.

Therefore, fossils within the borrow pit sites could be characterised as rare but highly significant. The damage and/or loss of these fossils due to inadequate mitigation would be a highly negative palaeontological impact. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) to a qualified palaeontologist for excavation will be a beneficial palaeontological impact.

Table 7.2 Significance Rating Table as Per CES Template

Rock Unit	Temporal Scale (duration of impact)	Spatial Scale (area in which impact will have an effect)	Degree of confidence (confidence with which one has predicted the significance of an impact)	Impact severity (severity of negative impacts, or how beneficial positive impacts would be)		Overall Significance (The combination of all the other criteria as an overall significance)	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Ceres Subgroup	permanent	international	possible	beneficial	severe	beneficial	Negative
Ecca Group	permanent	international	possible	beneficial	severe	beneficial	Negative
Tarkastad Subgroup	permanent	international	possible	beneficial	very severe	beneficial	High negative
Burgersdorp Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative

8. PALAEOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the field investigation. The field investigation confirms that most of the area is underlain by the Goudini Formation, Ceres Subgroup, Ecca Group, Tarkastad Subgroup and Burgersdorp Formation with Dolerite intrusions.

The Ceres Subgroup, Ecca Group, Tarkastad Subgroup and Burgersdorp Formation are interbedded mudstones and sandstones that do have potential to yield fossils. The excavation within these geological units' bedrock will have the potential to further uncover fresh mud rock and sandstone. Therefore monitoring and mitigation in terms of the palaeontological heritage are required.

Due to the igneous character of Dolerite it does not contain fossils and any excavations into dolerite do not require monitoring or mitigation in terms of palaeontological heritage.

The following colour coding method is used to classify a development area's palaeontological impact as illustrated in Figures 8.1 to 8.6:

- Red colouration indicates a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops on the site/route and the chances of finding fossils during the construction phase are very high.
- Orange colouration indicates a possibility of finding fossils of a specific assemblage zone either in outcrops or in bedrock on the site/route.
- Green colouration indicates that there is no possibility of finding fossils in that section of the site/route development.

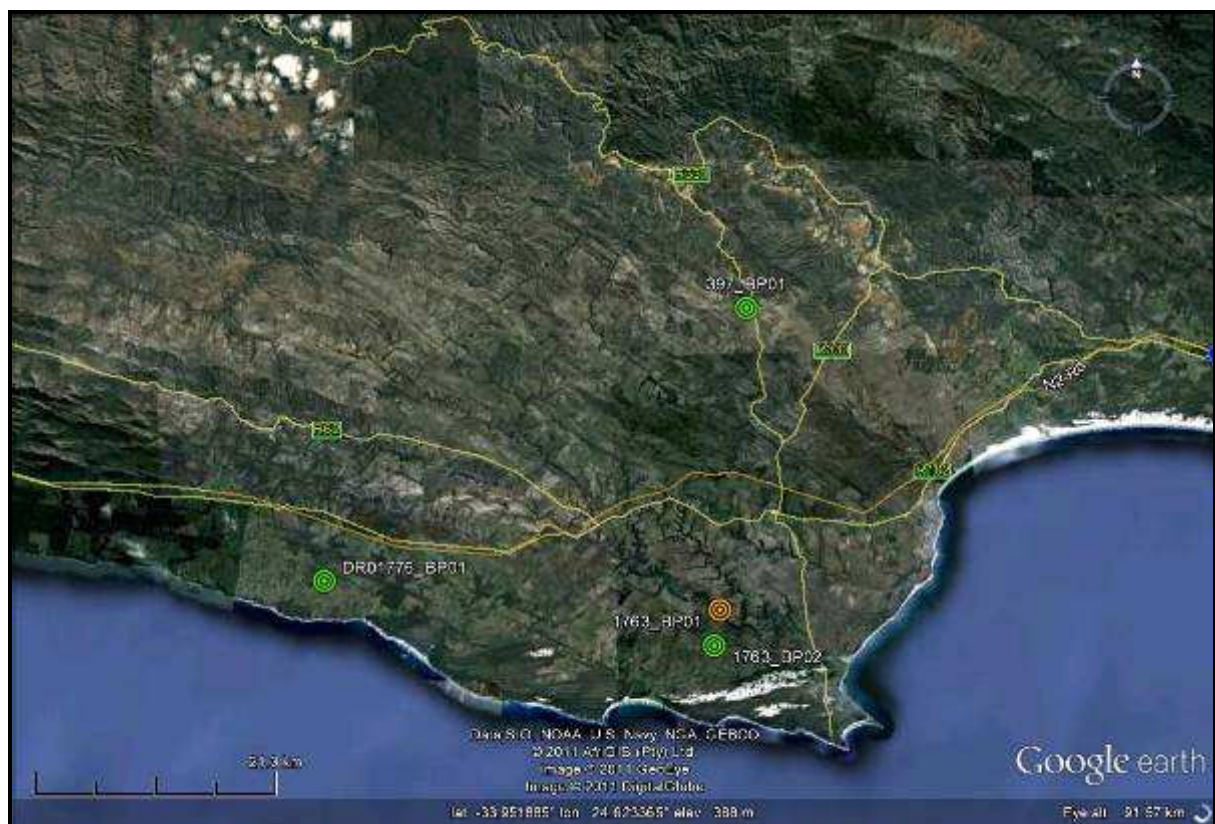


Figure 8.1 Palaeontological impact of the Cacadu District Municipality borrow pits.



Figure 8.2 Palaeontological impact of the Chris Hani District Municipality southern pits.

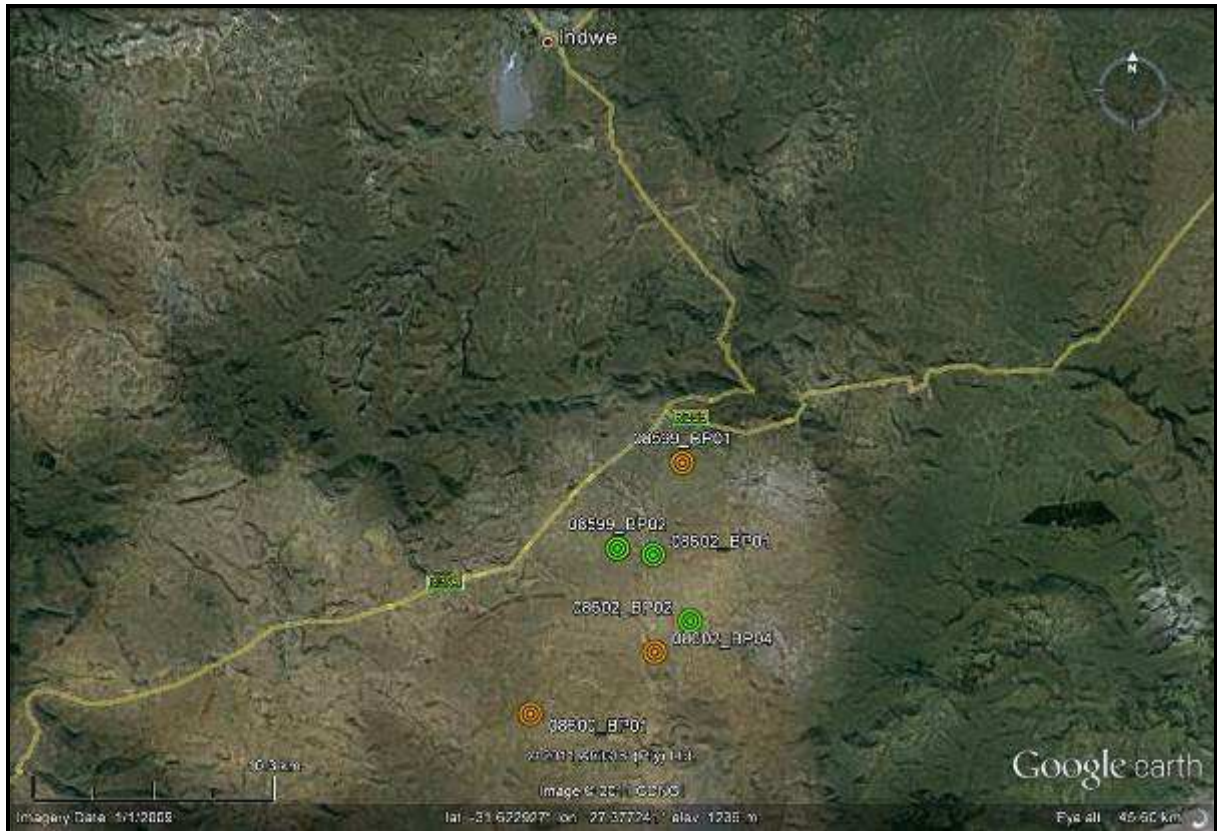


Figure 8.3 Palaeontological impact of the Chris Hani District Municipality northern pits.

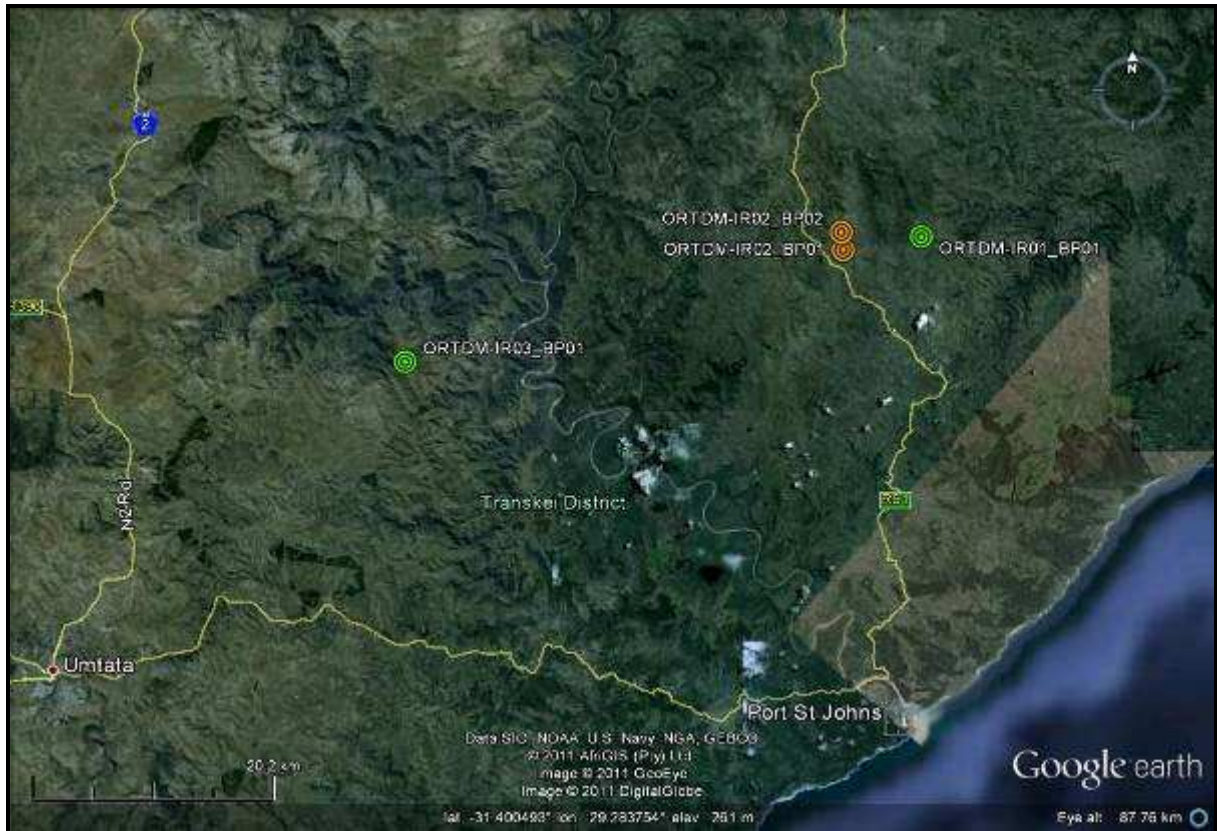


Figure 8.4 Palaeontological impact of the OR Tambo District Municipality southern pits.

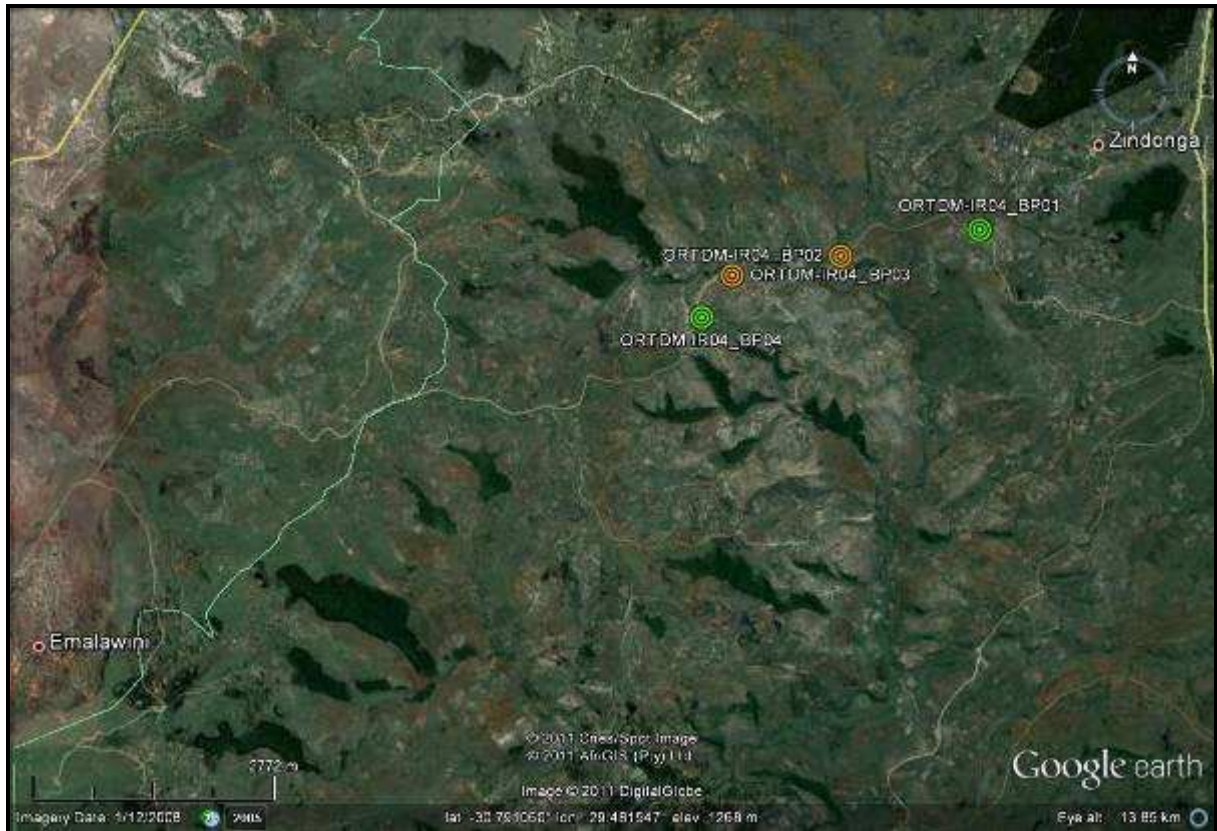


Figure 8.5 Palaeontological impact of the OR Tambo District Municipality northern pits.

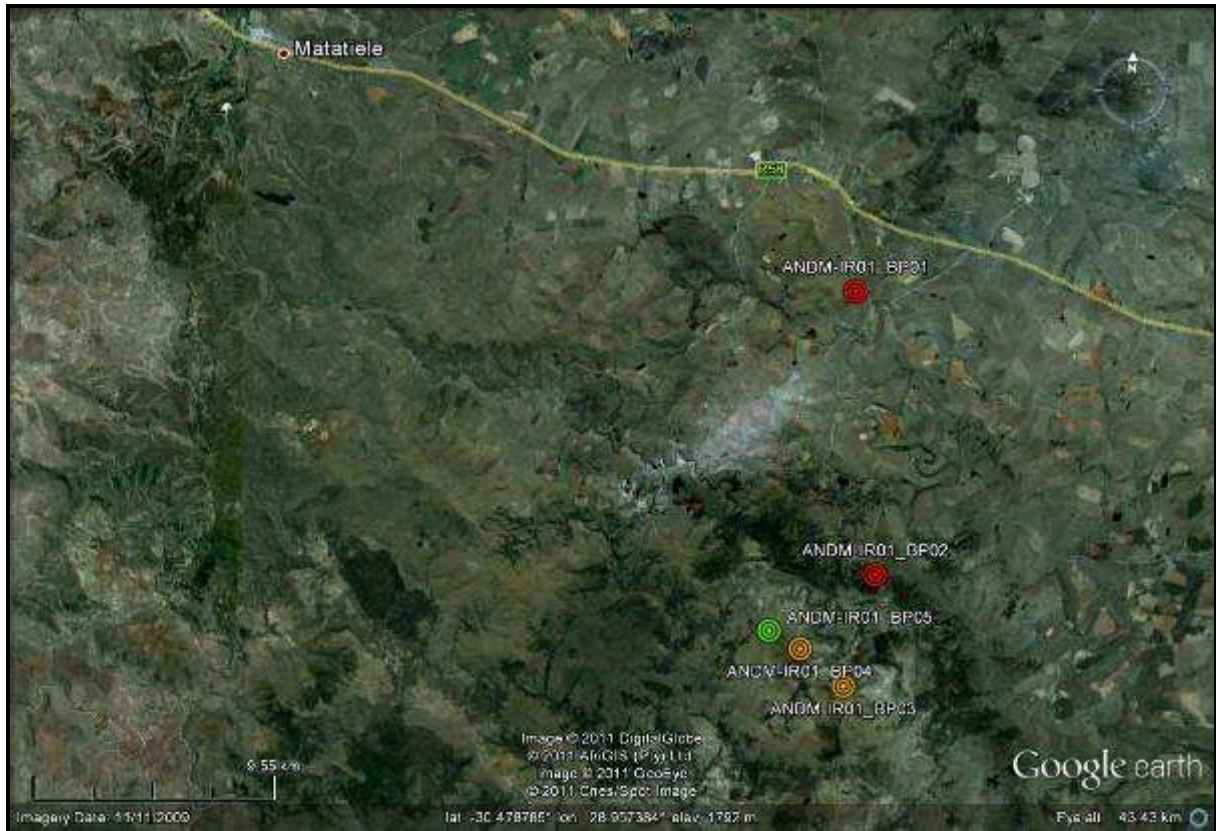


Figure 8.6 Palaeontological impact of the Alfred Nzo District Municipality borrow pits.

From Figure 8.1 and 8.6 the following mitigation measures are recommended:

Table 8.1 Site Specific Mitigation Measures

Colour Coding (Figures. 8.1 & 8.2)	Mitigation Recommended
Green Sites	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
Orange Sites	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
Red Sites	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.

9. CONCLUSION

The areas around the borrow pits are dominated by rolling hill topography. The underlying Ceres Subgroup, Eccca Group, Tarkastad Subgroup and Burgersdorp Formation are interbedded mudstones and sandstones. There is a high potential to uncover fossil material in these underlying mudstones during excavations.

The borrow pits in the Ceres Subgroup and Eccca Group have a medium palaeontological sensitivity rating. The borrow pits within the Beaufort Group, i.e. the consolidated Tarkastad Subgroup and the well defined Burgersdorp Formations within the Tarkastad Subgroup have a high palaeontological sensitivity rating.

Through adequate monitoring and mitigation measures during excavations of the Eccca and Beaufort Groups the medium to high impact severity can be lowered to beneficial. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) will have a beneficial palaeontological impact.

It is generally recommended that:

- A permit for the collection and rescue of fossils from the Ceres Subgroup, Eccca Group, Tarkastad Subgroup and Burgersdorp Formation must be obtained from SAHRA prior the construction phase.
- All earth-moving activities with potential impact on the Ceres Subgroup, Eccca Group, Tarkastad Subgroup and Burgersdorp Formation are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
- The resident ECO must also be trained by a professional palaeontologist in the recognition of fossil material. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation.
- The borrow pit specific recommendations is summarised in Table 9.1.

Table 9.1 Borrow Pit Specific Recommendations

Rd No	B/Pit No	Latitude (S)	Longitude (E)	Geology	Municipality	Mitigation Measures
Cacadu District Municipality						
DR01763	1763_BP01	34° 6'9.57"	24°43'10.00"	Dc	Kouga LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR01763	1763_BP02	34° 7'50.20"	24°42'48.00"	Sg	Kouga LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
MR00397	397_BP01	33°51'56.80"	24°45'1.00"	Sg	Kouga LM	
DR01776	DR01776_BP01	34° 4'21.40"	24°20'39.20"	Sg	Kou-Kamma LM	
Chris Hani District Municipality						
DR08599	08599_BP01	31°38'21.40"	27°24'32.60"	Trb & Jd	Emalahleni Lm	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08599	08599_BP02	31°40'19.80"	27°22'48.00"	Jd	Emalahleni LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
DR08600	08600_BP01	31°44'7.90"	27°20'28.70"	Trb & Jd	Emalahleni LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation

Rd No	B/Pit No	Latitude (S)	Longitude (E)	Geology	Municipality	Mitigation Measures
DR08602	08602_BP01	31°40'28.30"	27°23'46.20"	Jd	Emalahleni LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones
DR08602	08602_BP02	31°41'59.30"	27°24'46.60"	Jd	Emalahleni LM	
DR08602	08602_BP04	31°42'42.40"	27°23'49.40"	Trb & Jd	Emalahleni LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
R344 -CHDM-IR01	R344 -CHDM-IR01_BP01	32°18'24.15"	26°18'9.70"	Jd	Tsolwana LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones
R344 - CHDM-IR01	R344 - CHDM-IR01_BP02	32°18'46.90"	26°19'28.00"	Jd	Tsolwana LM	
R344 - CHDM-IR01	R344 -CHDM-IR01_BP03	32°19'31.70"	26°19'54.40"	Jd	Tsolwana LM	
DR07357	07357_BP01	32°19'34.00"	26°39'17.20"	Jd	Lukhanji LM	
DR07460	07460_BP02	32° 4'30.90"	26°35'4.00"	Trb	Lukhanji LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
OR Tambo District Municipality						
ORTDM-IR01	ORTDM-IR01_BP01	31°15'48.65"	29°33'20.67"	Jd	Ingquza Hill LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
ORTDM-IR02	ORTDM-IR02_BP01	31°16'25.30"	29°29'13.40"	Pe	Ingquza Hill LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR02	ORTDM-IR02_BP02	31°15'37.20"	29°29'7.10"	Pe	Ingquza Hill LM	
ORTDM-IR03	ORTDM-IR03_BP01	31°21'24.30"	29° 6'8.50"	Jd	Nyandeni LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones
ORTDM-IR04	ORTDM-IR04_BP01	30°46'13.6"	29°31'41.3"	Pe & Jd	Ntabankulu LM	

Rd No	B/Pit No	Latitude (S)	Longitude (E)	Geology	Municipality	Mitigation Measures
ORTDM-IR04	ORTDM-IR04_BP02	30°46'23.30"	29°30'38.70"	Pe	Ntabankulu LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ORTDM-IR04	ORTDM-IR04_BP03	30°46'31.13"	29°29'48.71"	Pe	Ntabankulu LM	
ORTDM-IR04	ORTDM-IR04_BP04	30°46'48.00"	29°29'34.40"	Pe & Jd	Ntabankulu LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.
Alfred Nzo District Municipality						
ANDM-IR01	ANDM-IR01_BP01	30°25'54.90"	29° 3'30.80"	Trt	Matatiele LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
ANDM-IR01	ANDM-IR01_BP02	30°32'0.86"	29° 4'3.37"	Trt	Matatiele LM	
ANDM-IR01	ANDM-IR01_BP03	30°34'28.50"	29° 3'20.80"	Trt & Jd	Matatiele LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
ANDM-IR01	ANDM-IR01_BP04	30°33'39.60"	29° 2'14.20"	Trt & Jd	Matatiele LM	
ANDM-IR01	ANDM-IR01_BP05	30°33'16.06"	29° 1'26.59"	Jd	Matatiele LM	Igneous/metamorphic rocks or quartzitic sandstone underlie these zones, with no potential for fossils.

10. REFERENCES

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11. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the Nelson Mandela Metropolitan University (1996) and the National Diploma in Nature Conservation from the University of South Africa (1990). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

Declaration of Independence

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

A handwritten signature in black ink, reading "Gideon Groenewald", with a horizontal line underneath it.

Dr Gideon Groenewald
Geologist

12. APPENDIX A - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

Although specialists will be given relatively free rein on how they conduct their research and obtain information, they will be required to provide their reports to the EAP in a specific layout and structure, so that a uniform specialist report volume can be produced.

To ensure a direct comparison between various specialist studies, a standard rating scale has been defined and will be used to assess and quantify the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed. Four factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.
3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word 'mitigation' means not just 'compensation', but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurs - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

The **environmental significance** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Negative impacts that are ranked as being of "**VERY HIGH**" and "**HIGH**" significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of "**MODERATE**" significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

Table 9-1: Criterion used to rate the significance of an impact

Significance Rating Table	
Temporal Scale (The duration of the impact)	
Short term	Less than 5 years (Many construction phase impacts are of a short duration)
Medium term	Between 5 and 20 years
Long term	Between 20 and 40 years (From a human perspective almost permanent).
Permanent	Over 40 years or resulting in a permanent and lasting change that will always be there
Spatial Scale (The area in which any impact will have an affect)	
Individual	Impacts affect an individual.
Localised	Impacts affect a small area, often only a portion of the project area.
Project Level	Impacts affect the entire project area.
Surrounding Areas	Impacts that affect the area surrounding the development
Municipal	Impacts affect either the Local Municipality, or any towns within them.
Regional	Impacts affect the wider district municipality or the province as a whole.
National	Impacts affect the entire country.
International/Global	Impacts affect other countries or have a global influence.
Will definitely occur	Impacts will definitely occur.
Degree of Confidence or Certainty (The confidence to predicted the significance of an impact)	
Definite	More than 90% sure of a particular fact. Should have substantial supportive data.
Probable	Over 70% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or of the likelihood of an impact occurring.

Table 9-2: The severity rating scale

Impact severity	
(The severity of negative impacts, or how beneficial positive impacts would be on a particular affected system or party)	
Very severe	Very beneficial
An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example the permanent loss of land.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit. For example the vast improvement of sewage effluent quality.
Severe	Beneficial
Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these. For example, the clearing of forest vegetation.	A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example an increase in the local economy.
Moderately severe	Moderately beneficial
Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated. For example constructing the sewage treatment facility where there was vegetation with a low conservation value.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way. For example a 'slight' improvement in sewage effluent quality.
Slight	Slightly beneficial
Medium or short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example a temporary fluctuation in the water table due to water abstraction.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect	Don't know/Can't know
The system(s) or party(ies) is not affected by the proposed development.	In certain cases it may not be possible to determine the severity of an impact

Table 3: Overall significance appraisal

Overall Significance (The combination of all the above criteria as an overall significance)	
VERY HIGH NEGATIVE	VERY BENEFICIAL
<p>These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects.</p> <p>Example: The loss of a species would be viewed by informed society as being of VERY HIGH significance.</p> <p>Example: The establishment of a large amount of infrastructure in a rural area, which previously had very few services, would be regarded by the affected parties as resulting in benefits with VERY HIGH significance.</p>	
HIGH NEGATIVE	BENEFICIAL
<p>These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as HIGH will need to be considered by society as constituting an important and usually long term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light.</p> <p>Example: The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated.</p> <p>Example: The change to soil conditions will impact the natural system, and the impact on affected parties (such as people growing crops in the soil) would be HIGH.</p>	
MODERATE NEGATIVE	SOME BENEFITS
<p>These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial.</p> <p>Example: The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.</p>	
LOW NEGATIVE	FEW BENEFITS
<p>These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect.</p> <p>Example: The temporary change in the water table of a wetland habitat, as these systems is adapted to fluctuating water levels.</p> <p>Example: The increased earning potential of people employed as a result of a development would only result in benefits of LOW significance to people who live some distance away.</p>	
NO SIGNIFICANCE	
<p>There are no primary or secondary effects at all that are important to scientists or the public.</p> <p>Example: A change to the geology of a particular formation may be regarded as severe from a geological perspective, but is of NO significance in the overall context.</p>	
DON'T KNOW	
<p>In certain cases it may not be possible to determine the significance of an impact. For example, the significance of the primary or secondary impacts on the social or natural environment given the available information.</p> <p>Example: The effect of a particular development on people's psychological perspective of the environment.</p>	