# PHASE 1 PALAEONTOLOGICAL ASSESSMENT FOR THE PROPOSED CONSTRUCTION OF CLEARWATER PIPELINES FROM THE SANDILE WTW TO THE BURNSHILL AND BRITISH RIDGE RESERVOIRS WITHIN THE AMATHALTHI AND RAYMOND MHLABA LOCAL MUNICIPALITIES IN THE AMATHOLE DISTRICT MUNICIPALITY EASTERN CAPE PROVINCE

**For:**

## EOH Coastal & Environmental Services

**DATE: 16 August 2017**

**By**

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## EXECUTIVE SUMMARY

Gideon Groenewald was appointed by EOH Coastal & Environmental Services to undertake a Phase 1 survey, assessing the potential palaeontological impact of the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province.

The purpose of this 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.

This report forms part of the Basic Environmental Impact Assessment for the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province.

The development site for the proposed construction and upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province, is underlain by by Permian aged Beaufort Group mudstone and sandstone and Jurassic aged Dolerite of the Karoo Supergroup.

The development sites are underlain by shallow soils and several areas are underlain by poorly defined outcrops of the Beaufort Group is well-defined outcrops of grey and greenish-grey mudstone of the Balfour Formation, Adelaide Subgroup.

Although fossils were difficult to identify and only observed in areas of good outcrop and in burrow pits during the field investigation, the potential for finding significant fossils in slightly weathered sedimentary rocks of all the Geological groups are high to very high. Due to the fact that no fossils were observed in the areas where deep soils cover the geological formations, the predicted Palaeontological sensitivity was reduced to a more realistic allocation. It is however important that a qualified palaeontologist be appointed to inspect all the excavation sites in sections of the route designated a High and Very High Palaeontological sensitivity where excavation will exceed 1.5m. From the field study it is confirmed that fossils were observed at all the sites where bedrock of sedimentary rock formations were exposed.

The developer must be notified of the possibility of exposing significant fossils during excavation of the trenches for the installation of pipelines. A qualified palaeontologist must be appointed to inspect all exposure of bedrock and where fossils are recorded, the palaeontologist must apply for a permit to collect the fossils according to SAHRA specifications. The fact that extended parts of the development sites are underlain by rocks with a Very High Palaeontological sensitivity and that trenching might expose significant fossils, must be noted in the EMP of the project.

No fossils will be present in Jurassic aged dolerite.

It is recommended that:

- The EAP and ECO must be informed of the fact that a Very High Palaeontological Sensitivity is allocated to extended sections of the proposed upgrading of the Amatola Water Supply Scheme.
- A qualified palaeontologist must be appointed to apply for a permit to record and collect all fossils found along sections underlain by rocks of Balfour Formation of the Beaufort Group, as part of a Phase II PIA for the project according to SAHRA specifications.
- These recommendations must form part of the EMP of the project.

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# INTRODUCTION

Gideon Groenewald was appointed by EOH Coastal & Environmental Services to undertake a Phase 1 survey, assessing the potential palaeontological impact of the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province.

The purpose of this 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.

## Legal Requirements

This report forms part of the Basic Environmental Impact Assessment for the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province.

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; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

# AIMS AND METHODOLOGY

A Phase 1 investigation is often the last opportunity to record the fossil heritage within the development footprint. These records are very important to understand the past and form an important part of South Africa's National Estate.

Following the "SAHRA APM Guidelines: *Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports*" the aims of the palaeontological impact assessment are:

- to identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assessing the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to the field investigation a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps (3226 King Williams' Town) in conjunction with Google Earth. Potential fossiliferous rock units (groups,

formations etc) were identified within the study area and the known fossil heritage within each rock unit was inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

Priority palaeontological areas were identified within the development footprint to focus the field investigator's time and resources. The aim of the fieldwork was 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 likely impact of the proposed development on local fossil heritage was determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the minimal extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

**Table 1 Colour Coding for Palaeontological Sensitivity Classes**

| **PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS** | |
|---|---|
| The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008) and Groenewald et al (2014) | |
| | |
| **RED** | Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction ) as well as application for collection and destruction permit compulsory. |
| **ORANGE** | High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects. |
| **GREEN** | Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended. |

| | |
|---|---|
| **BLUE** | Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Collection of a representative sample of potential fossiliferous material is recommended. |
| **GREY** | Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during implacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits. |

When rock units of Moderate to Very High palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

## Scope and Limitations of the Phase 1 Investigation

The scope of a phase 1 Investigation includes:

- an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units;
- a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports;
- data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and
- where feasible, location and examination of any fossil collections from the study area (e.g. museums).
- an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The

investigation focussed on the bedrock exposure where excavations would most probably require palaeontological monitoring.

The results of the field investigation are then used to predict the potential of buried fossil heritage within the development footprint. In some investigations this involves the examination of similar accessible bedrock exposures, such as road cuttings and quarries, along roads that run parallel to or across the development footprint.

## LOCALITY AND PROPOSED DEVELOPMENT

The Project area covers a small part of the much larger proposed Amatola Water Reticulation Project with a total distance of close to 210 km, from Keiskammahoek, north west of King's Williams to Canon Rocks on the coast (Groenewald 2015, EOH Internal Report). The study area covers only a small part of an array of landscapes, varying from open plains to rugged mountain land and deep river valleys and this survey focuses specifically on the section with observation points 731 to 739 in an earlier study (Groenewald 2015, EOH Internal Report). The project proposes to upgrade the water reticulation system for the Amatola Municipality through the construction of new and upgraded water distribution pipelines, reservoirs and pumping stations.

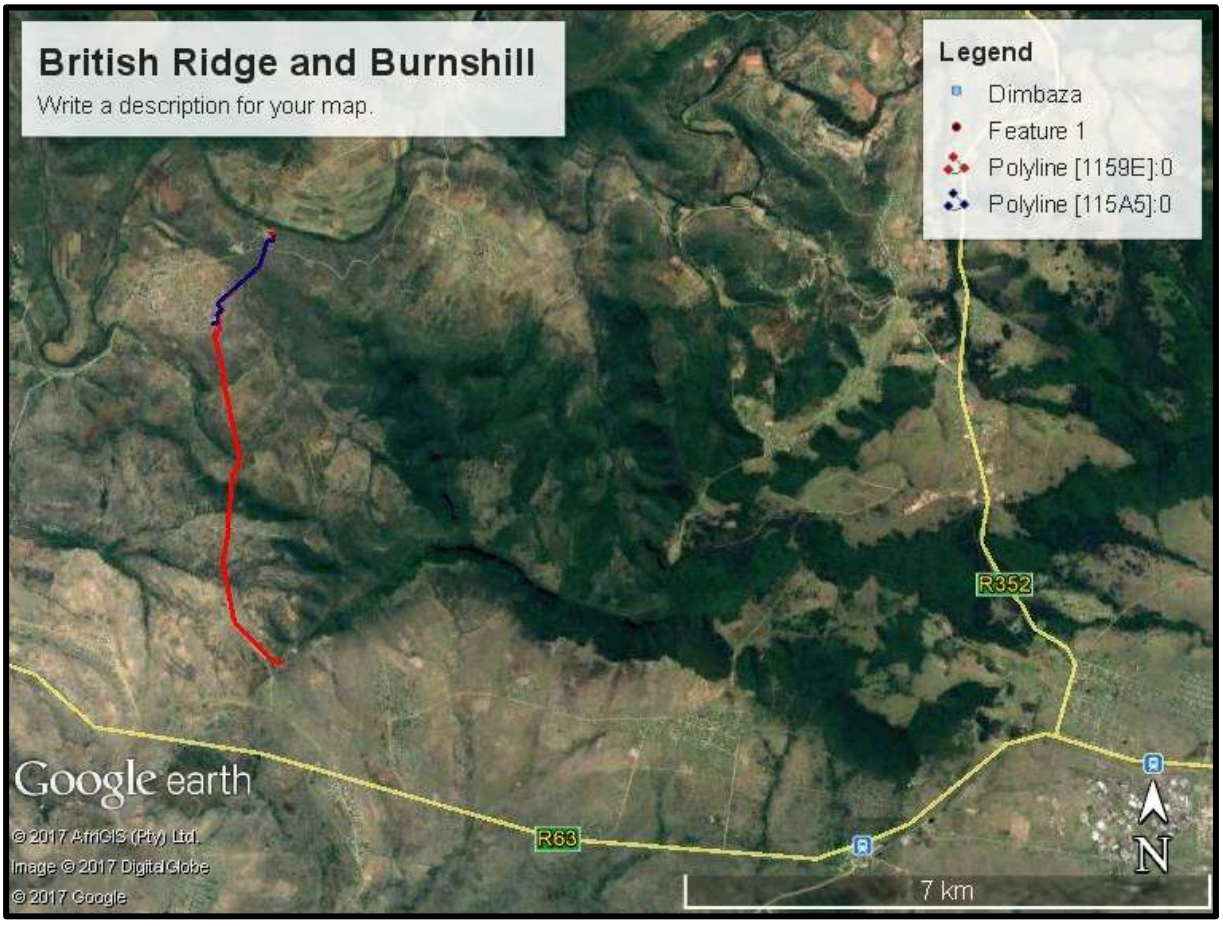


**Figure 1 Locality of the route of the pipeline in this study**

# GEOLOGY OF THE AREA

Following a desktop survey it was established that the site of the proposed upgrading of the Amatola Water Infrastructure is underlain by Permian aged Beaufort Group mudstone and sandstone and Jurassic aged Dolerite of the Karoo Supergroup (Figure 2).


**Figure 2 Geology underlying the route of the study site comprises the Balfour Formation (Pub) and Dolerite (Jd)**

## Karoo Supergroup

Starting in the Late Carboniferous and continuing into the following Permian and Triassic Periods, dense oceanic crust flooring the **Panthalassa Ocean** to the south of Gondwana began to sink down beneath the edge of the supercontinent, eventually to be recycled back into the hot mantle below. This process, known as *subduction*, compressed the Gondwana crust, including the Cape Supergroup rocks within the Cape Basin situated to the north of the Falkland Plateau. The resulting folding and thrust faulting of the Cape sediments, as well as the underlying older crust, gave rise to the **Cape Fold Belt** between 280 and 230 Ma. Levels of deformation and metamorphism within the Cape Fold Belt were quite low, and were not associated with the intrusion of hot granitic magmas. Therefore preservation of Cape Supergroup fossils within many parts of the Cape Fold mountains, is often remarkably good.. The Cape Fold Belt is just the local sector of a much more lengthier, Himalayan-scale belt of fold mountains called the **Gondwanides** that stretched along the entire southern margin of Gondwana. Subduction, crustal compression and collision events here and elsewhere during the Carboniferous and Permian can be seen as the final stages of assembly of a new **Supercontinent Pangaea**. This vast landmass, which at its acme incorporated all the major crustal blocks on the planet and stretched from pole to pole, lasted less than 100 million years before breaking up again. The southern region of Pangaea incorporating Africa is still known as Gondwana and was stable enough to survive more or less intact for millions of years following the fragmentation of Pangaea. Loading of the southern margin of Gondwana / Pangaea by the thickly piled-up rocks forming the Cape Fold Belt caused a broad compensatory depression to form on the inner side of the mountains. This was the **Main Karoo Basin** – another example of a foreland basin. Over the succeeding 100 million years (Late Carboniferous to Early Jurassic Periods) it was gradually infilled with glacial, marine / lacustrine and continental sediments of the **Karoo Supergroup** with a total thickness of around 10-12km.

This investigation comprises a discussion of only the Permian aged Balfour Formation and Jurassic aged Dolerite of the Karoo Supergroup.

## Beaufort Group

For 90 million years or so of its existence the Main Karoo Basin was essentially dry land – a vast, monotonous, semi-arid to desert plain, embedded deep within Gondwana, ringed by craggy fold mountains in the south and west, and by more subdued uplands of basement rocks elsewhere. As southern Gondwana drifted further from the southern palaeopole into warmer latitudes and the youthful Cape Fold Mountains rose along its southern and western margins, huge volumes of siliciclastic sediment were fed into the landlocked Karoo Basin by a series of Mississippi-sized meandering rivers. Sandstones and thin conglomerates were laid down within the sinuous river channels stretching far into the basin (coarser sediments deposited closer to the mountain source areas have not been preserved). Occasionally, perhaps during seasonal floods, these rivers burst over their low, well-vegetated banks to deposit large quantities of finely layered silt and mud on the adjacent floodplain. Between floods, calcrete-rich soils typical of semi-arid climates developed on the floodplain, which was also dotted in wetter times by pools and even extensive shallow lakes. The several kilometre-thick succession of fluvial and lacustrine sediments of Late Permian to Early Triassic age that accumulated within the Main Karoo Basin in Late Permian to Early Triassic times (*c*. 266-250 Ma) is known as the Beaufort Group.

#### Adelaide Subgroup

The Permian aged Adelaide Subgroup is a thick sequence of sedimentary rocks dominated by light grey to yellow coloured fine-grained sandstones with interbedded green, grey and red coloured shale. These sandstones and mudstones were deposited in ancient meandering rivers alongside which lay vast swamplands. Burial of plant and animal remains lead to a wealth of fossils preserved in these sediments (Johnson et al, 2009).

*Balfour Formation (Pub)*
The Balfour Formation consists primarily of a sequence of grey-coloured mudrock and sandstone, with a prominent upper Triassic aged Palingkloof Member, that is characterised by red mudstone.

From the south, the study area is therefore underlain by sedimentary rocks of the Permian aged Adelaide Subgroup, capped by Permian aged sediments of the Balfour Formation (Pub), dominated by grey-green coloured mudstone units (Figure 2).

#### Karoo Dolerite
The deposition of the sedimentary sequence of the Karoo Supergroup was terminated by a major volcanic event that is associated with the breakup of Gondwanaland during the Jurassic. The study area is in some local places underlain by Jurassic aged dolerite sills.
(Figure 2).

# PALAEONTOLOGY OF THE AREA

## Karoo Supergroup

## Beaufort Group

This sequence of sediments is rated as some of the most productive deposits of Permian aged plant fossils of *Glossopteris* assemblages in South Africa. At their peak development during the Permian these plants inhabited a variety of ecological niches, including riverine forests and was dominated by cycadeoids, ginkos and conifers. Rich assemblages of insects are also recorded from these

sequences. From the Desktop survey it is concluded that the study area falls in the middle to upper part of the Adelaide Subgroup and is underlain by rocks of both the Middleton and Balfour Formations.

The Beaufort Group is famous among palaeontologists for its impressive fauna of terrestrial and freshwater vertebrates. Most notable is a wide range of herbivorous and carnivorous therapsids ("mammal-like reptiles") that constituted the dominant group of large tetrapods in the Late Permian / Early Triassic interval, long before the ascendancy of the dinosaurs. This was the period when the first complex, vertebrate-dominated ecosystems were established on land. These featured small-bodied insectivores, crocodile-sized amphibians, and herds of specialised megaherbivores (*eg* dinocephalians, dicynodonts) that were hounded in life and scavenged after death by some of the oldest known terrestrial superpredators (*eg* gorgonopsians). Although there must have been fairly lush *Glossopteris* and horsetail-dominated vegetation to support these intricate foodwebs, especially along moister riverbanks and lake margins, environmental conditions did not favour preservation of many fossil plants. The Karoo Basin lay at palaeolatitudes of around 70º S during early Beaufort Group times. Climates were continental and therefore highly seasonal, with alternating long, hot summers and cold, dark winters. Far from the Panthalassic Ocean, and in the rainshadow of the lofty Gondwanide mountains, annual rainfall was probably variable and low, as in the modern Karoo, so water imported by perennial rivers must have played an important ecological role. Many smaller animals probably escaped drastic fluctuations in variations in food supply (*eg* new plant growth, or insects) and availability of free water through hibernation or aestivation in underground burrows. Some larger animals, such as some of the social dicynodonts, dinocephalians and their predators, may even have abandoned the vast plains of the Karoo Basin each year in times of physiological or ecological stress, undertaking long seasonal migrations across southern Pangaea. The sediments and fossils of the lower Beaufort Group (**Adelaide Subgroup**) are of additional palaeontological interest because they provide the best available record for environmental and biotic changes on land during two successive mass extinction events. These are the end-Mid Permian (end-Guadalupian) event of 260.4 Ma, which affected large dinocephalian therapsids as well as flora, and the even more catastrophic end- Permian event of 251.4 Ma. The latter may have wiped out over 90% of living plant and animal species and marked the dramatic end of the Palaeozoic Era. Recent data from the Main Karoo Basin and elsewhere indicate that both extinction events were associated with episodes of extreme global warming leading to protracted, severe drought across much of Pangaea. The resulting mass die-off of terrestrial vegetation also entailed radical changes in sedimentation patterns (*eg* high rates of soil erosion, prevalence of braided river systems, flash floods, red beds), and finally precipitated the almost complete collapse of terrestrial ecosystems. The ultimate trigger of dramatic global warming in the Mid to Late Permian remains controversial, but may have involved the release of tremendous volumes of methane (a powerful greenhouse gas) from buried coal deposits in China and Siberia when these were extensively intruded by hot basaltic magmas of LIPs. The youngest Karoo Supergroup sediments in the Northern Cape belong to the lower part and the youngest Karoo Supergroup sediments in the Northern Cape and Eastern Cape belong to the upper Beaufort Group (**Tarkastad Subgroup**) of Early Triassic age (*c*. 250 Ma). They crop out on the eastern edge of the province south of Colesburg. These reddish mudrocks and buff braided river sandstones reflect persistent arid conditions following the end-Permian biotic catastrophe. They yield abundant skeletal remains and burrows of the pig-sized herbivorous therapsid *Lystrosaurus* that flourished across Pangaea in Early Triassic times in the absence of large land predators. Small burrowing cynodonts – the sophisticated therapsid subgroup that gave rise to the first true mammals by the end of the Triassic Period – are also found.

## Adelaide Subgroup

**Balfour Formation (Pub)**

As with the Middleton Formation, rich assemblage of vertebrates, including some of the more advanced Mammal-like Reptiles, are associated with these rock sequences. Fossils associated with the Balfour Formation include vertebrates from the *Daptocephalus* Assemblage Zone and *Lystrosaurus* Assemblage Zone (Rubidge et al, 1995; MacRae, 1999; McCarthy and Rubidge, 2005; Johnson et al, 2009). Several important trace fossil assemblages, including vertebrate tracks and casts of vertebrate burrows have been described from the Formation (Groenewald, 1996; Johnson *et al*., 2009).

# PRELIMINARY ASSESSMENT RESULTS

The palaeontological sensitivity was predicted after identifying potentially fossiliferous rock units; ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself. The palaeontological sensitivity for the different geological groups and formations were predicted as being from very highly significant to very low or insignificant, depending on the potential abundance of Permian aged fossils, including plant fossils, vertebrate fossils and invertebrate fossils from the entire range geological palaeo-environments that are represented in the study area (Figure 4)

# FIELD INVESTIGATION

Dr Gideon Groenewald, experienced fieldworker, visited the site of the proposed the proposed Amamtola to Cacadu Water Supply Scheme on Tuesday 9 June 2015 to Friday 12 June 2015 (Internal

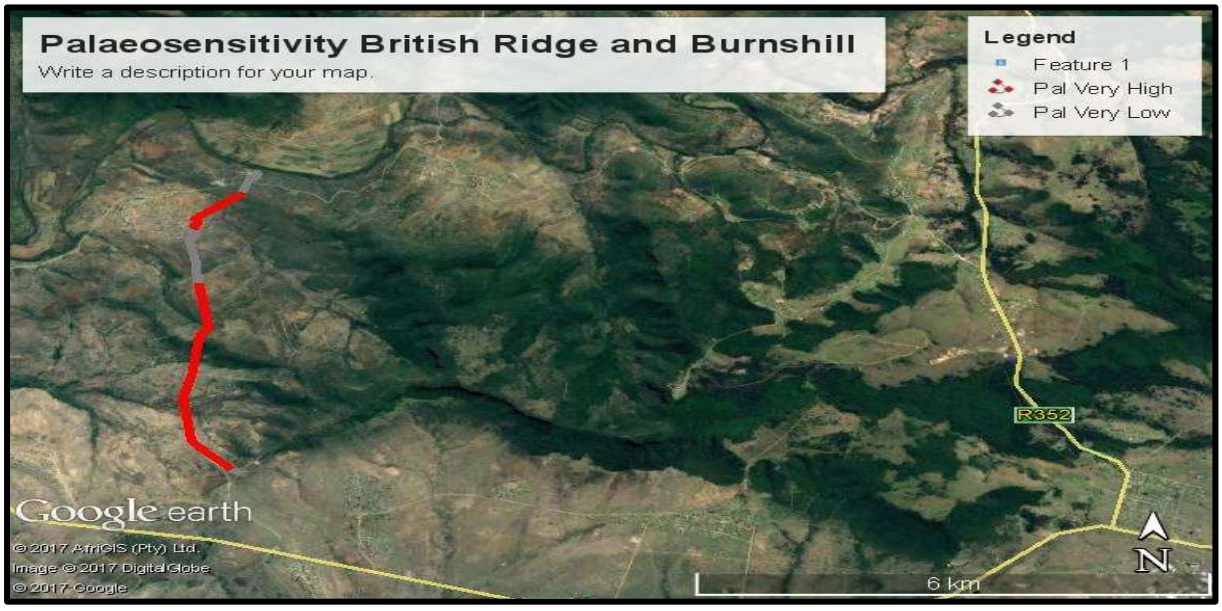


**Figure 3 Palaeontological Sensitivity of the study area**

Report at EOH, Groenewald, 2015). The topography of the study area varies from rugged mountain land in the north to undulating plains and rugged river valleys in the central areas, with gently undulating hills and plains in the southern region. The soil cover vary from relatively deep (>1.5m) soils in the valley floors, to relatively shallow (<1.0m) soils on slightly weathered sandstone and mudstone of the Karoo Supergroup. In the study area, rocks of the Karoo Supergroup give rise to relatively deep (>1.5m) sandy soils.

Excavations for the construction of the proposed Amatola Water Supply Scheme will be restricted to areas close to the roads and can be underlain by soils of varying depth. The proposed sites of the upgrading of the Amatola Water Supply Scheme were investigated and possible impacts on palaeontological heritage were recorded at specific GPS stations (Figure 4)

The results of the field surveys are discussed in terms of this specific section between Middledrift to British Ridge and Burnshill, based on specific landmarks identified during the study.

Photographic records were kept for different GPS stations and the results are presented in photographic tables.

## Keiskammahoek to Middledrift

The fieldwork results are discussed in terms of specific GPS stations that represent most of the area close to the GPS sites (Figure 4). Geology of the route is presented in Figure 3. Photographic records of observations are recorded in Table 2.

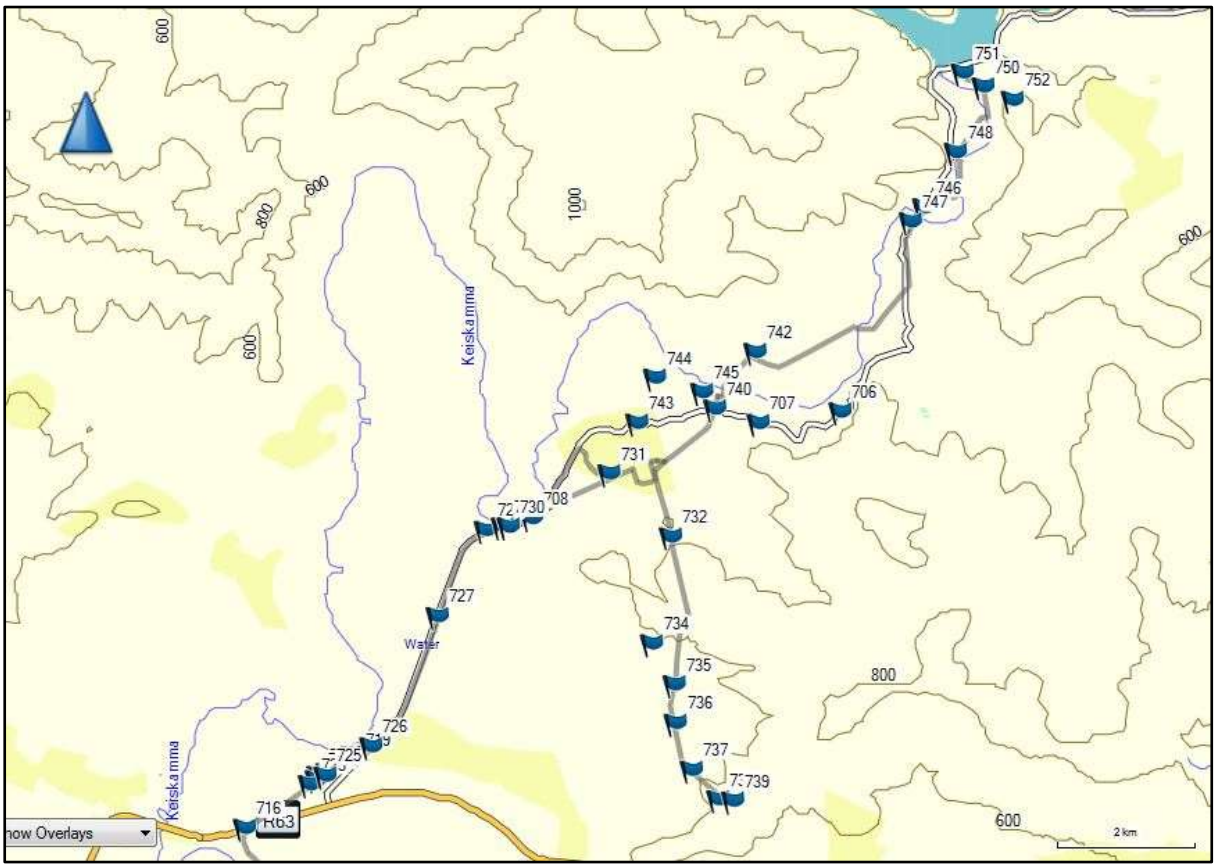


**Figure 4 Observations for this study was specific at along the route with GPS sites 731 to 739**

**Table 2 Photographic record of observations Keiskammahoek to Middledrift**

| Photo | GPS station no (Fig. 4) and coordinates | Description | Picture |
|---|---|---|---|
| 9 | (731)<br>-32° 46' 19.0"<br>27° 03' 22.0"" | No exposures. Shallow soil on Balfour Formation mudstone. No fossils observed. |  |
| 10 | (732)<br>-32° 46' 48.5"<br>27° 03' 52.4" | Deep soils on deeply weathered dolerite. No fossils. |  |
| 11 | (734)<br>-32° 47' 38.4"<br>27° 03' 43.1" | Sandy shale of the Adelaide Subgroup, Balfour Formation. Very shallow soils, mudrock exposure, high potential for fossils during excavation. No fossils observed during field inspection. |  |
| 12 | (735)<br>-32° 47' 57.4"<br>27° 03' 54.2" | No outcrop. Excavation will be into sandstone and mudstone of the Adelaide Subgroup, Balfour Formation. No fossils observed. |  |

| | | | |
|---|---|---|---|
| 13 | (736)<br>-32° 48' 15.4"<br>27° 03' 54.7" | Relatively shallow soils on sandstone and mudstone of the Adelaide Subgroup, Balfour Formation. Excavation will probably expose bedrock with slight chance of exposing fossils. No outcrop and fossils observed during fieldwork. |  |
| 14 | (737)<br>-32° 48' 37.3"<br>27° 04' 02.7" | Relatively shallow to deep soil on weathered mudstone of the Adelaide Subgroup, Balfour Formation. No outcrop, no fossils observed. |  |
| 15 | (738)<br>-32° 48' 51.0"<br>27° 04' 15.8" | Shallow soils and outcrop of Adelaide Subgroup, Balfour Formation sediments. No fossils observed during fieldwork. High potential to find fossils during excavation of trenches. |  |
| 16 | (739)<br>-32° 48' 51.7"<br>27° 04' 23.1" | Dolerite and mudstone of the Adelaide Subgroup, Balfour Formation, exposed during construction. Excavation for pipeline might expose fossils. No fossils were observed during field inspection. |  |

## Palaeontological 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 the study area is underlain by medium-grained sandstone and

green to grey coloured mudstone beds of the Balfour Formation, Adelaide Subgroup, Karoo Supergroup.

In the region between Keiskammahoek and Middledrift the excavations for the layout for the Upgrading of the Amatola Water Supply Scheme will be into shallow soils and partly weathered to unweathered sediments of the Balfour Formation, Adelaide Subgroup. Due to expected weathering of the sediments of the Adelaide Subgroup and the observation that a large part of the proposed sites is underlain by soil and partly weathered sandstone and mudstone, fossils will be difficult to identify. Exposure of bedrock during excavation is highly likely and might have a significant impact on the palaeontology of the sites. The fact that very few significant fossils were observed during the field investigation leads to the retention of the Palaeotological Sensitivity of Very Highly significant for most of the route, accept where the route is underlain by dolerite (Figure 5). If fossils are observed they must be recorded and collected according to SAHRA specifications.

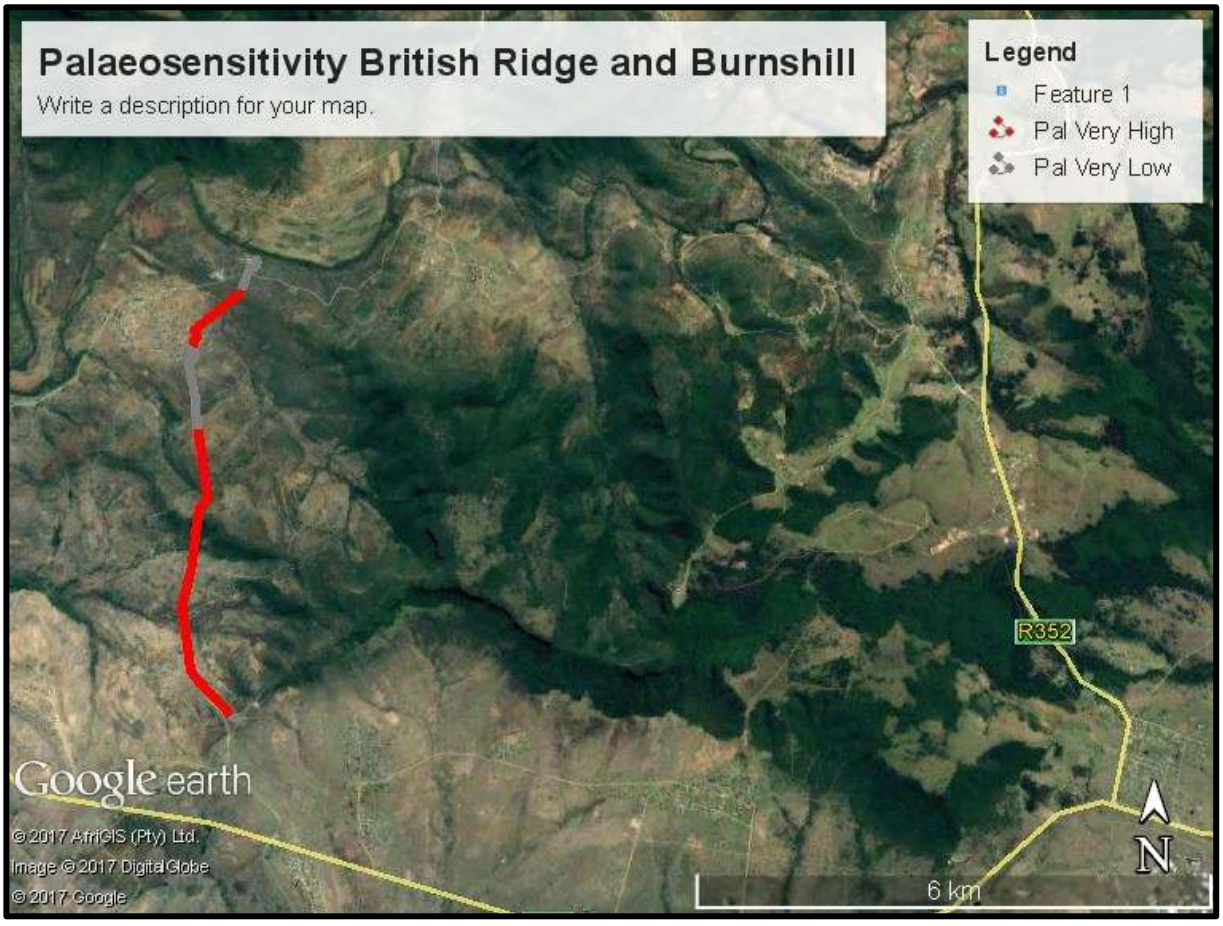


**Figure 5 Palaeontological Sensitivity of the areas underlying the pipeline route**

Where excavations for the pipeline will expose bedrock at 1.5m excavations, a qualified palaeontologist must be appointed to inspect all excavation sites that are allocated a Very High Palaeontological sensitivity where fossils are expected along the route between GPS stations 231 and 239 at Britsh Ridge and Burnshill (Figure 4). Where fossils are found, they must be recorded and collected according to SAHRA specifications.

# CONCLUSION

The development site for the proposed construction and upgrading of the Amatola Water Infrastructure, Amathalthi and Nkonkobe Local Municipalities in the Amathole District Municipality, Eastern Cape Province, is underlain by by Permian aged Beaufort Group mudstone and sandstone and Jurassic aged Dolerite of the Karoo Supergroup.

The development sites are underlain by shallow soils and several areas are underlain by poorly defined outcrops of the Beaufort Group. These outcrops are invariably well-defined outcrops of grey and greenish-grey mudstone of the Balfour Formation, Adelaide Subgroup.

Although fossils were difficult to identify and only observed in areas of good outcrop and in borrow pits during the field investigation, the potential for finding significant fossils in slightly weathered sedimentary rocks of the Beaufort Group is very high. Due to the fact that no fossils were observed in the areas where deep soils cover the geological formations, the predicted Palaeontological sensitivity will only be significant where geotechnical reports indicate potential exposure of bedrock during excavation. Where excavation will exceed 1.5m, it is important that a qualified palaeontologist be appointed to inspect all the excavation sites in sections of the route designated a Very High Palaeontological sensitivity. From the previous field study (Groenewald 2015, Internal Report EOH), it is confirmed that fossils were observed at all the sites where bedrock of sedimentary rock formations were exposed.

The palaeontologist must apply for a permit to collect the fossils according to SAHRA specifications.

No fossils will be present in Jurassic aged dolerite.

It is recommended that:

- The EAP and ECO must be informed of the fact that a Very High Palaeontological Sensitivity is allocated to extended sections of the proposed upgrading of the Amatola Water Supply Scheme.
- A qualified palaeontologist must be appointed to apply for a permit to record and collect all fossils found along sections underlain by rocks of Balfour Formation of the Beaufort Group, as part of a Phase II PIA for the project according to SAHRA specifications.
- These recommendations must form part of the EMP of the project.

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## QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). 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 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.

**Dr Gideon Groenewald**
**Geologist**