PHASE 1 *PALAEONTOLOGICAL IMPACT ASSESSMENT REPORT*

Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline

Free State Province of South Africa
Mangaung Local Municipality

Consultant:

Enviroworks

04 April 2013

By:

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Enviroworks Environmental Consultants to undertake a Phase 1 Palaeontological Field Investigation, assessing the potential palaeontological impact of the Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline. The purpose of this Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed project, to assess the impact the project may have on this resource, and to make recommendations as to how this impact might be mitigated.

This report forms part of the full environmental impact assessment and complies with 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 development footprint.

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000, 2926-Bloemfontein) maps in conjunction with Google Earth. A review of the literature on the geological formations exposed at the 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 27 March 2013, 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 mainly underlain by Permian and Triassic sedimentary rocks of the Karoo Supergroup. The sedimentary sequence consists of the lower Adelaide Subgroup and Upper Tarkastad Subgroup of the Karoo Supergroup. Jurassic Dolerite sills dominate the hilltops while the low lying areas are overlain by recent Quaternary Alluvium deposits.

During the desktop survey, a significant 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 can be described as significant due to the abundance of Permian and Triassic fossils including remains of therapsids known to occur within the Adelaide and Tarkastad Subgroups.

During the field investigation it was confirmed that the study area is mainly underlain by Permian and Triassic sedimentary rocks of the Adelaide and Tarkastad Subgroups of the Karoo Supergroup. Jurassic Dolerite sills dominate the high laying areas while recent Quaternary Alluvium deposits occur in the river valleys.

There is little possibility that fossils could be encountered during shallow excavation of the Adelaide and Tarkastad Subgroups as well as colluvial deposits in the study area.

Recommendation:
There is little possibility that fossils will be encountered during shallow excavation of the Adelaide and Tarkastad Subgroups, as well as colluvial deposits. Therefore, the palaeontological sensitivity will be low for both alternative routes with no significant heritage impact, with the exception of a very short section on alternative route 1 close to the Klein Modder River. The ECO must be informed of the possibility of fossils in deeply excavated sediments of the Adelaide and Tarkastad Subgroups. If fossils are recorded, a qualified palaeontologist must be notified and the fossils removed according to SAHRA specifications.

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1. INTRODUCTION

1.1. Background

Gideon Groenewald was appointed by Enviroworks Environmental Consultants to undertake a Phase 1 Palaeontological Field Investigation, assessing the potential palaeontological impact of the proposed Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline. This report complies with 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 development footprint.

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.

1.2. 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 were:

- 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 (2926 Bloemfontein) 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 1.1 below.

Sensitivity	Description
Low Sensitivity	Areas where there is likely to be a negligible impact on the fossil heritage. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.
Moderate Sensitivity	Areas where fossil bearing rock units are present but fossil finds are localised or within thin or scattered sub-units. Pending the nature and scale of the proposed development the chances of finding fossils are moderate. The developer should be made aware of the potential for finding fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to the appropriate Heritage Authority so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense.
High Sensitivity	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in outcrops and exposed bedrock. The chances of finding fossils during excavations by a professional palaeontologist are high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan. The mitigation should involve the comprehensive recording and collection of surface and embedded fossils along and close to the development footprint by a professional palaeontologist.

Table 1 Palaeontological sensitivity analysis outcome classification

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

1.3. 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).
- do an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The investigation should focus on the sites where bedrock excavations would definitely 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.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The development entails the construction of approximately 15km of 700mm diameter steel pipeline from the Rustfontein Plant to the Lesaka Reservoir. The proposed pipeline is to be constructed parallel to an existing 660mm diameter steel pipeline where possible. It is envisaged that the new pipeline route will follow open spaced areas in the built up regions of the city and two alternative route alignments have been proposed.

Figure 2.2 Site plan of existing pipeline.

Figure 2.1 Site plan of existing (yellow) and the two alternative routes (alternative 1 – red; alternative 2 – blue) of the Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline

3. GEOLOGY OF THE AREA

The study area is mainly underlain by Permian and Triassic sedimentary rocks of the Karoo Supergroup (Figure 3.1). The sedimentary sequence consists of the lower Adelaide Subgroup and Upper Tarkastad Subgroup of the Karoo Supergroup. On the map provided in figure 3.1, the Adelaide Subgroup equates with the Lower Beaufort (K3l), whereas the Tarkastad Subgroup includes both the Middle Beaufort (K3m) and Upper Beaufort (K3u) Jurassic Dolerite (Jd) sills dominate the hilltops while the low lying areas are overlain by recent Quaternary Alluvium deposits (not shown on map).

Figure 3.1 Geology of the study area at Botshabelo (Geo Maps 2926 Bloemfontein)

3.1. The Adelaide Subgroup

The Adelaide Subgroup (K3l) is interpreted as fluvial sediments with channel sandstones (meandering rivers), thin mudflake conglomerates interbedded with floodplain mudrocks (green and maroon), pedogenic calcretes, playa lake and pond deposits and occasional reworked volcanic ashes (Johnson et al, 2006 and Groenewald 1996). The upper part of the Subgroup is interpreted as mostly shallow lacustrine deposits and is represented by brightly coloured (greenish grey and maroon) siltstones (Groenewald 1996).

3.2. Tarkastad Subgroup

The Tarkastad Subgroup consists of a lower arenaceous unit (K3m) and an upper red argillaceous unit (K3u). The lower unit also known as the Katberg Formation consists of largely sandy braided river deposits and forms prominent outcrops of flat-bedded and low-angled, cross-bedded fine-grained sandstone. The upper unit, also known as the Burgersdorp Formation, is not present in the study area.

3.3. Karoo Dolerite

Dolerite (Jd, mapped as red polygons on map) is a very hard igneous rock that intruded the sedimentary layers and can occur either as sills or dykes. Sills can be from a few meters to tens of meters thick. Good examples of weathered dolerite were observed in the informal borrow-pits that are situated nearby the Eastern end of the pipeline route.

3.4. Quaternary Deposits

The Quaternary Deposits consist of alluvial deposits, deposited by rivers in the valley floors (not shown on map)

4. PALAEONTOLOGY OF THE AREA

4.1. The Adelaide Subgroup

The upper part of the Adelaide Subgroup is globally known for its productive palaeontological characteristics. The rock unit contains fossils of both the *Dicynodon lacerticeps* Assemblage Zone and the *Lystrosaurus* Assemblage Zone. These biozones are known for their wealth of fossilised therapsids and mark the geological boundary between the Permian and Triassic Periods. Plant fossils of the *Glossopteris* Flora as well as examples of Horsetails (*Sphenophyta)* have been described from the *Dicynodon lacerticeps* Assemblage Zone. Casts of vertebrate burrows have been described from the *Lystrosaurus* Assemblage zone (Groenewald 1991).

4.2. The Tarkastad Subgroup

Only the lower Katberg Formation is present in the study area. Not many vertebrate fossils have been described from the arenaceous units in this part of the Karoo Basin (Groenewald 1996), although tracks of vertebrates, possibly *Lystrosaurus*, is known from outcrops close to Botshabelo (Figure 6.13)

The upper Burgersdorp Formation, not present in the study area, represents the *Cynognathus* Assemblage Zone.

4.3. Karoo Dolerite

Due to the igneous character of Karoo Dolerite it will not contain fossils.

4.4. Quaternary Deposits

No fossils are expected in the alluvial deposits of recent rivers.

5. 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 can be described as significant due to the potential abundance of Permian and Triassic fossils including remains of, therapsids known to occur within the Adelaide and Tarkastad Subgroups.

6. FIELD INVESTIGATION

Dr Gideon Groenewald, Sue Groenewald and David Groenewald, experienced fieldworkers, visited the site of the proposed Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline on Wednesday 27 March 2013. The topography of the area is undulating with extensive colluvial deposits and more rugged exposures of dolerite sills and dykes. No fossil remains were observed during the field investigation. A well-defined trackway, possibly of *Lystrosaurus*, was observed in an outcrop of Katberg Formation Sandstone close to Botshabelo.

Figure 6.1 Industrial Development at the Rustfontein Plant with no outcrops

Figure 6.2 Western Section of Pipeline route, mainly underlain by Dolerite. No potential for fossils

Figure 6.4 Flat landscape underlain by Adelaide Formation. No outcrops of sedimentary rocks, no fossils observed. (GPS: S29° 15' 44,1" E26° 38' 51,4")

Figure 6.3 Route of existing pipeline in built up area, no outcrop, no fossils observed.

(GPS: S29° 15' 23,5" E26° 40' 56,0")

Figure 6.6 River valley, wetland, no outcrop, no fossils observed
(GPS: S29° 14' 36,2" E 26° 41' 42,6")

Figure 6.5 Existing pipeline crossing the Klein Modder River. No outcrops, no fossils observed
(GPS: S29° 15' 10,4" E26° 41' 59,5")

Figure 6.8 Pipeline crosses valley floors in built up areas. No outcrops, no fossils observed. (GPS: S29° 15' 00,5" E26° 42' 30,3")

Figure 6.7 Dolerite outcrop. no fossils observed. (GPS: S29° 14' 45,1" E26° 43' 52,9")

Figure 6.9 Typical wetland scene, no outcrops, no fossils observed

Figure 6.10 Dolerite outcrop at the end of pipeline at Lesaka Reservoir. No fossils (GPS: S29° 14' 51,8" E26° 44' 49,3")

Figure 6.12 Unoficial dolerite quarry. No fossils. (GPS: S29° 14' 49,5" E26° 44' 33,8")

Figure 6.11 Outcrop of Katberg Sandstone as lenses in dolerite. No fossils observed (GPS: S29° 14' 49,4" E26° 44' 32,8")

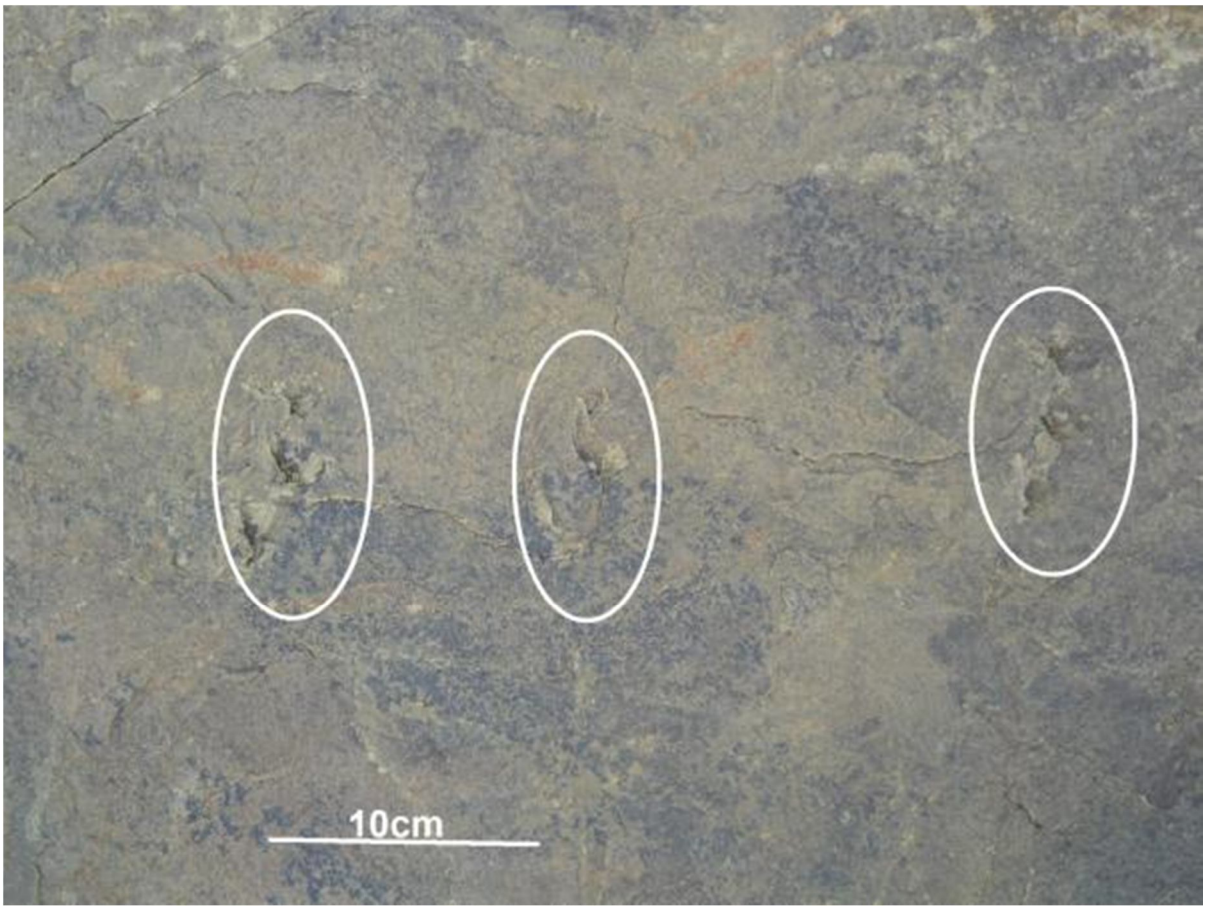

Figure 6.1 Trackway of therapsid, possibly *Lystrosaurus* in Katberg Sandsrone near Botshabelo

7. PALAEONTOLOGICAL SENSITIVITY AND SIGNIFICANCE

The desktop study suggests that the area is underlain by the Adelaide and Tarkastad Subgroups and will thus be highly sensitive for palaeontological heritage. However, the field investigation results indicate that due to the colluvial deposits and large areas underlain by dolerite, the potential for finding fossils is limited. Therefore, with the exception of a very short section on alternative 1, the palaeontological sensitivity will be low with no significant heritage impact as illustrated in Figure 7.1.

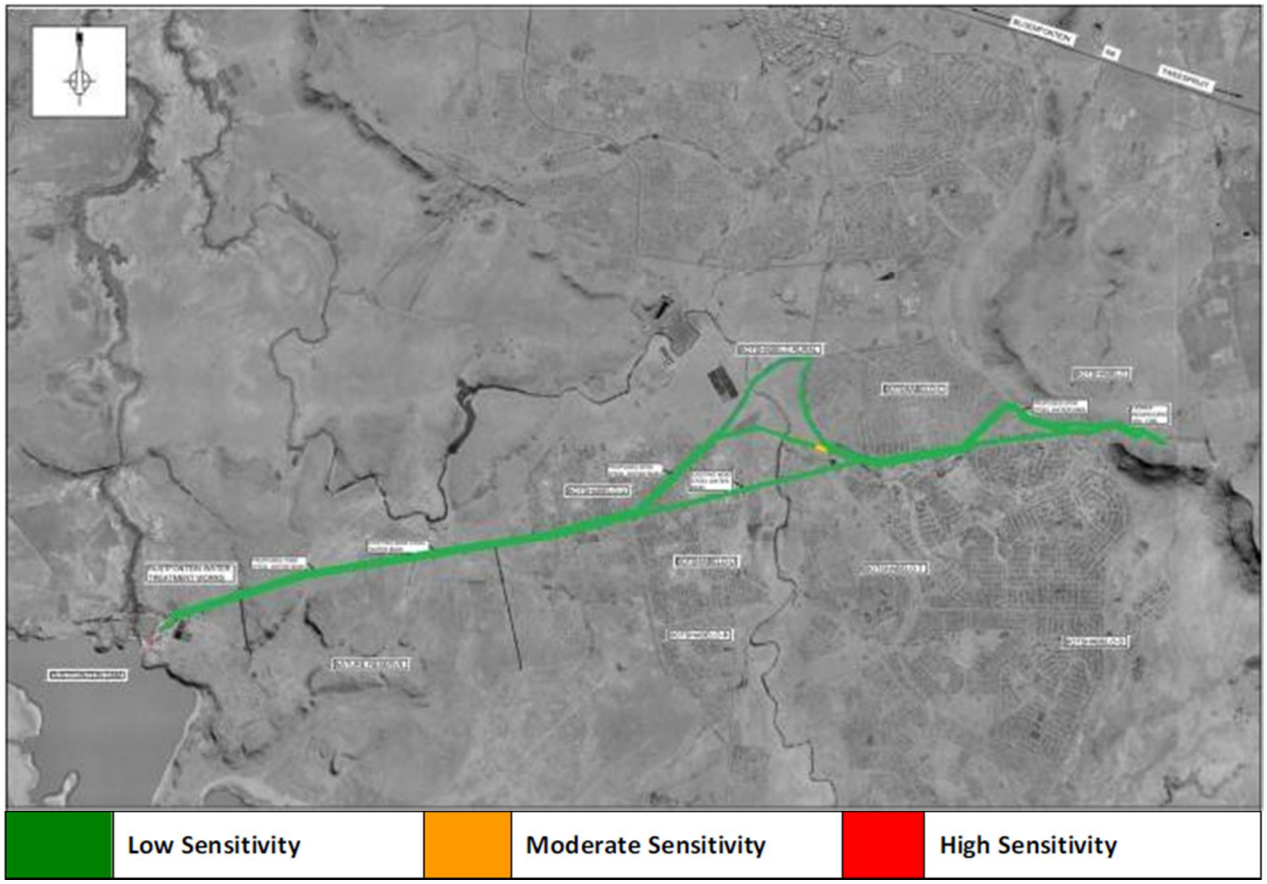

Figure 7.2 Sensitivity map for the existing and proposed routes of the Bloemwater: RustfonteinDam/Botshabelo Water Supply Pipeline

8. CONCLUSION AND RECOMMENDATIONS

The study area is mainly underlain by Permian and Triassic sedimentary rocks of the Adelaide and Tarkastad Subgroups of the Karoo Supergroup. Jurassic Dolerite sills and dykes dominate the high laying areas with recent Quaternary Alluvium deposits occurring in the river valleys.

There is little possibility that fossils will be encountered during shallow excavation of the Adelaide and Tarkastad Subgroups, as well as colluvial deposits. Therefore, the palaeontological sensitivity will be low for both alternative routes with no significant heritage impact, with the exception of a very short section on alternative route 1 close to the Klein Modder River. The ECO must be informed of the possibility of fossils in deeply excavated sediments of the Adelaide and Tarkastad Subgroups. If fossils are recorded, a qualified palaeontologist must be notified and the fossils removed according to SAHRA specifications.

9. REFERENCES

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10. 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 palaeo-ecological 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).

11. 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