PALAEONTOLOGICAL IMPACT ASSESSMENT REPORT

Lusikisiki Regional Water Supply Scheme, OR Thambo District Municipality, Eastern Cape Province.

FOR

Coastal and Environmental Services

by

Gideon Groenewald

04 September 2014
EXECUTIVE SUMMARY

Gideon Groenewald was appointed to undertake a Phase 1 Palaeontological Impact Assessment, assessing the potential palaeontological impact of the proposed Lusikisiki Regional Water Supply Scheme (LRWSS), located within the OR Thambo District Municipality in the Eastern Cape. 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 project 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 project.

A study done in 2010 reported that a combination of surface water (Zalu Dam) and groundwater would be the most feasible solution for the long-term water supply for the LRWSS. The Zalu Dam was found to be the most feasible surface storage option for the areas around Lusikisiki, with the south-western part of the study area requiring supplies from groundwater. The Department of Water Affairs (DWA) proposes to begin the second phase of the scheme to augment the existing water supply in the area from Lusikisiki to Port St Johns (Ingquza Hill and Port St John’s Local Municipalities). This will involve two water resources:

- The construction of the Zalu Dam on the Xura River to the west of Lusikisiki, which will also involve the upgrading of the Lusikisiki water treatment works and the expansion of the potable water reticulation in the Lusikisiki area; and
- A groundwater abstraction scheme in the south, which will augment water supplies to Port St Johns and the surrounding areas.

The Study area is underlain from East to West by Cambrian to Ordovician aged quartzites of the Natal Group, Carboniferous to Permian aged tillite of the Dwyka Formation and Permian aged shale, sandstone and mudstone of the Ecca Group, Karoo Supergroup. Parts of the study area are underlain by Jurassic aged Dolerite that intruded into the surrounding country rock and Quaternary aged Alluvial deposits underlie the valley floors near present day rivers in the study area.

The Natal Group quartzites, Dolerite and Alluvium are not known to contain significant fossils whereas numerous fossils have been described from the Dwyka Formation and Ecca Group in South Africa. In the study area the Dwyka Formation tillites and Ecca Group shales are, however, very deeply weathered and no fossils were observed in these rocks during this investigation. A Low Palaeontological sensitivity is therefore allocated to all the routes of the pipelines, the reservoir sites and the proposed construction site of the Zalu Dam. Due to the fact that deep excavation of Ecca Group shales is expected at the construction site of the Zalu Dam wall and spillway, it is recommended that the ECO of the project be informed of the possibility that fossils (notably trace fossils) might be present in freshly exposed shales at the construction site of the Zalu Dam wall and spillway.

It is recommended that:

1. The ECO of the project be informed of the slight possibility that trace fossils might be exposed on the bedding planes of Ecca Group shales during deep excavations for the construction of the Zalu Dam wall and spillway. If fossils are recorded the palaeontologist, Eastern Cape Heritage Authority and SAHRA must be notified and the fossils recorded according to SAHRA specification.

2. No further mitigation for Palaeontological Heritage needs to be planned for this project.
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1. INTRODUCTION

Gideon Groenewald was appointed to undertake a Phase 1 Palaeontological Impact Assessment, assessing the potential palaeontological impact of the proposed Lusikisiki Regional Water Supply Scheme, located within the OR Thambo District Municipality in the Eastern Cape. 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.

1.1. Legal Requirements

This report forms part of the Basic Environmental Impact Assessment for the proposed project 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 project.

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.

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 (3128 Umtata) 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 extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 2.1 below.

Table 2.1 Palaeontological sensitivity analysis outcome classification

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Sensitivity</td>
<td>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.</td>
</tr>
<tr>
<td>Moderate Sensitivity</td>
<td>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.</td>
</tr>
<tr>
<td>High Sensitivity</td>
<td>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.</td>
</tr>
</tbody>
</table>

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.

2.1. 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.
3. PROPOSED DEVELOPMENT DESCRIPTION

Project History:
The LRWSS was originally planned in 1978 as a regional scheme to utilize a dam on the Xura River. Only phase 1 of the originally planned larger scheme has been implemented to date, and the dam has never been built. This phase was commissioned in July 1989 and currently supplies the town of Lusikisiki (11 000 people) and 23 surrounding villages (41 000 people). The town of Lusikisiki is provided with full water services, including house connections and water borne sanitation, but the level of services for the villages is limited to bulk water supply to village reservoirs (CES 2014).

Current Status:
The current capacity of the bulk water supply infrastructure is 2 760 m3/day. Water is pumped from a weir on the Xura River and conveyed by gravity to the pump station which is located near the weir. The water is then pumped to the existing Water Treatment Works (WTW). After treatment the potable water is conveyed to bulk storage reservoirs at various points in the area, which in turn feed 24 service reservoirs that supply rural villages. The current scheme is not able to meet the water requirements in the area and water shortages are experienced frequently. This low assurance of water supply can be attributed to the following reasons:

- Inadequate capacity of existing infrastructure;
- The poor condition of existing infrastructure;
- Significant housing development in the area, which has significantly increased water use requirements in the area.

A study done in 2010 reported that a combination of surface water (Zalu Dam) and groundwater would be the most feasible solution for the long-term water supply for the LRWSS. The Zalu Dam was found to be the most feasible surface storage option for the areas around Lusikisiki, with the south-western part of the study area requiring supplies from groundwater. The Department of Water Affairs (DWA) proposes to begin the second phase of the scheme (Figure 3.1) to augment the existing water supply in the area from Lusikisiki to Port St Johns (Ingquza Hill and Port St John’s Local Municipalities). This will involve two water resources:

- The construction of the Zalu Dam on the Xura River to the west of Lusikisiki, which will also involve the upgrading of the Lusikisiki water treatment works and the expansion of the potable water reticulation in the Lusikisiki area; and
- A groundwater abstraction scheme in the south, which will augment water supplies to Port St Johns and the surrounding areas.
4. GEOLOGY OF THE AREA

The Study area is underlain from East to West by Cambrian to Ordovician aged quartzites of the Natal Group, Carboniferous to Permian aged tillite of the Dwyka Formation and Permian aged shale, sandstone and mudstone of the Ecca Group, Karoo Supergroup. Parts of the study area are underlain by Jurassic aged Dolerite that intruded into the surrounding country rock and Quaternary aged Alluvial deposits underlie the valley floors near present day rivers in the study area.

4.1. Natal Group (S?)

The Cambrian to Ordovician (possibly Silurian) aged rocks of the Natal Group are predominantly light grey quartzitic sandstone and minor interbedded shales. Structures preserved in these sandstones indicate that the sediments were transported and deposited by rivers that drained highlands to the northeast. Close to their source, in northern KZN, deep valleys were in-filled with thick accumulations of boulders and pebbles.

4.2. Dwyka Formation (Pd)

The Carboniferous to Permian aged Dwyka Formation consists of dark-grey tillite that was deposited by retreating Glaciers. The tillite is generally deeply weathered and where exposed in quarries, the rock unit is characterised by a rich assemblage of dropstones that vary in size from millimetre scale to nearly a meter in diameter.

4.3. Ecca Group (Pe)

The Permian aged Ecca Group is undifferentiated and comprises of dark grey shale, mudstone and fine-grained sandstone. The sedimentary rocks are deeply weathered and mostly only exposed in deep excavations for road cuttings and quarries. The Ecca Group rocks are interpreted as a deep water deposit of silts and clays in the Ecca Sea.
Permin aged Dolerite sills and dykes are present throughout the study area, but particularly in the Western parts. These deposits represent magma intrusions into the Karoo Supergroup and older Natal Group sediments during the Jurassic volcanic episode that occurred during the breakup of Gondwanaland.

4.4. Alluvium

Quaternary aged Alluvium is present in the river valleys, consisting mostly of fine-grained sand and clay deposits with boulder beds at the base of river channels.
5. PALAEOLOGY OF THE AREA

The potential palaeontology of a rock unit relates directly to the geology of the area. Desktop surveys include the comparison of relevant referenced geological maps and locality maps and/or waypoints provided for the development project.

5.1. Natal Group (S?)

Up to date, no fossils have been described from the Natal Group quartzites which are most probably of Silurian age. Trace fossils have however been recorded from similar aged rocks in the Cape Supergroup, and recording of fossils from this rock unit will be significant.

5.2. Dwyka Formation (Pd)

Trace fossils have been recorded from the fine-grained shales of the Dwyka Formation in KwaZulu-Natal (Linstrom, 1987; MacRae, 1999). All of the following could therefore potentially be found in this formation. Trackways, produced mostly by fish and arthropods (invertebrates), have been recovered in shales from the uppermost Dwyka Formation. Other trace fossils include coprolites (fossilized faeces) of chondrichthyians (sharks, skates and rays).

Body fossils include aranaceous foraminifera and radiolarians (single-celled organisms), bryozoans, sponge spicules (internal support elements of sponges), primitive starfish, orthoceroid nautiloids (marine invertebrates similar to the living *Nautilus*), goniatite cephalopods (*Eoasinites* sp.), gastropods (marine snails such as *Peruvispira vipedoridensis*), bivalves (*Nuculopsis* sp., *Phestia* sp., *Aphanaia haiensis*, *Eurydesma mytiloides*), brachiopods (*Attenuatella* sp.) and palaeoniscoid fish such as *Namaichthys schroederi* and *Watsonichthys lotzi*.

Fossil plants have also been found, including lycopods (*Leptophloem australis*), moss, leaves and stems (possibly belonging to a proto-glossopterid flora). Fossil spores and pollens (such as moss, fern and horsetail spores and primitive gymnosperm pollens) as well as fossilized wood probably belonging to primitive gymnosperms have also been recorded from Dwyka deposits (MacRae, 1999; McCarthy and Rubidge, 2005).

5.3. Ecca Group (Pe)

Trace fossils have been described from the deep water deposits of this Group in various places in the Karoo Basin, whereas plant fossils are abundantly present in the sandstone rich units in the northern parts of the Basin.

The bivalve *Megadesmus* is described from the Late Permian upper Volksrust Shale Formation in the north-eastern Karoo Basin, South Africa. This is the first reported discovery of this genus in Africa. The fossil is large, 9 cm dorsally and 8.4 cm laterally, and both valves are articulated indicating minimum transport after death. The bivalve was encased in interbedded siltstone-shale that constitutes the distal sediments of a prograding delta at the Beaufort –Ecca Group boundary. *Megadesmus* is known from other continents (Australia, India, Siberia, South America and Tasmania) where its presence indicates exclusively marine conditions. The implication for the northeastern Karoo Basin during the Late Permian is that a marine enclave still existed in this geographic area and that terrestrial conditions did not yet prevail as in the southern basin region (Cairncross et al., 2005).

5.4. Karoo Dolerite (Jd)

Due to the igneous character of these rocks they do not contain fossils.
5.5. Alluvium

No significant fossils have been described from the alluvium deposits in this part of South Africa. Significant fossils have however been described from similar deposits in the Free State Province and recording of fossil finds from the alluvium deposits in the study area will be highly significant.

6. 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. Due to the known presence of trace fossils in rocks of the Dwyka Formation and Ecca Group, a Moderate Palaeontological sensitivity was allocated to these rock units, requiring a Phase 1 Palaeontological Impact Assessment (PIA). Although the potential for fossils in rocks of the Natal Group and the Alluvial deposits are low, site visits were planned to do preliminary investigations and record any possible fossils from these units. The dolerite units will not have associated fossils.

7. FIELD INVESTIGATION

Dr Gideon Groenewald and David Groenewald, experienced fieldworkers, visited the study area of the Lusikisiki Regional Water Supply Scheme between Wednesday 26 August 2014 and Thursday 28 August 2014. The topography of the area is dominated by rolling hills with isolated cliffs in regions where outcrops of Natal Group quartzite and dolerite occur. The methodology followed for fossil hunting mainly entailed driving along all the routes of the proposed pipelines where exposure of bedrock was expected in erosion dongas, road cuttings or quarries and excavations as envisaged from Google Earth images. All exposures of bedrock were inspected for fossils.

7.1. Routes underlain by Natal Group Quartzites

Quartzites of the Natal Group underlies the north-eastern part of the study area (Figure 7.1). The quartzite outcrops form some of the most spectacular cliffs in this region (Figures 7.2 and 7.3). The outcrops were inspected for the presence of possible trace fossils, but none were recorded during this investigation.

7.2. Routes underlain by Dwyka Formation tillites

The tillites of the Dwyka Formation is present in the central, east and north-east of the study area and are mostly weathered to a depth of several meters, giving rise to a landscape of rolling hills (Figure 7.4 and 7.5). The weathering of the tillite leads to the accumulation resistant boulders of dropstones in the soil profiles on site. Fresh exposure of Dwyka Formation tillite was observed in a working quarry where good examples of the tillite with dropstones of varying sizes were observed (Figure 7.6). No fossils were recorded from the tillite deposits.

7.3. Routes underlain by Ecca Group shale

The shale and fine-grained sandstone of the Ecca Group is also deeply weathered, with an associated topography of rolling hills with relatively deeply incised valleys in the central and western part of the study area (Figure 7.7). The sedimentary rocks are deeply weathered and outcrops of bedrock are restricted to road cuttings where weathering causes exposure of thinly bedded, but highly weathered shale with well-defined bedding planes (Figure 7.8). In some cases, weathered shale samples were exposed in smaller excavations that were made for the installation of infrastructure, possibly pipelines or electrical cables (Figure 7.9). No trace fossils were however recorded from these weathered rocks. Outcrops of fresh bedrock were restricted to a few quarries in the study area (Figure 7.10) and these outcrops were investigated for possible presence of trace fossils. No fossils were recorded from the shale deposits of the Ecca Group during this investigation.
7.4. Routes and Quarries underlain by Dolerite

Due to the igneous character of dolerite it will not contain fossils and all the routes underlain by this rock type will not contain fossils. Dolerite quarries (Figure 7.11) for provision of material for road fill and hard rock (Burrow 1 and Burrow 2 (Figure 7.12)) will not contain fossils.

7.5. Spillway of the proposed Zalu Dam

The spillway of the proposed Zalu Dam is underlain by shale of the Ecca Group. Outcrops of the shale formation are restricted to small (20cm) ledges of highly weathered shale on a grass-covered slope (Figure 7.13). A small test pit was excavated into the shale formation and although bedding planes are well defined in the highly weathered shale, no fossils were observed.

7.6. Alluvium in the basin of the proposed Zalu Dam

The valley floor in the basin of the proposed Zalu Dam is underlain by Quaternary aged alluvium, with gravel and pebble layers associated with the channel base deposits (Figure 7.14). During this investigation, no fossils were observed in the alluvium deposits.
Figure 7.2 Prominent cliff faces formed by the Natal Group Quartzites
(GPS: 31° 19' 55.99"S 29° 46' 40.7"E)

Figure 7.3 Spectacular cliffs of Natal Group Quartzites near Port St Johns
(GPS: 31° 36' 14.27"S 29° 31' 39.38"E)
Figure 7.4 Rolling hill topography characteristic of the Dwyka Formation
(GPS: 31° 21' 30.08"S 29° 41' 58.47"E)

Figure 7.5 Freshly exposed Dwyka Tillite in a quarry. Note the deeply weathered nature of this formation. (GPS: 31° 21'13.38"S 29° 30' 36.3"E)
Figure 7.6 Tillite with dropstones (GPS: 31° 21’ 13.71”S 29° 40’ 38”E)

Figure 7.7 Ecca Group is also deeply weathered, with an associated topography of rolling hills with relatively deeply incised valleys in the central and western part of the study area (GPS: 31° 19’ 51.5”S 29° 27’ 9.05”E)
Figure 7.6 Typical road cutting outcrop of Ecca Group Shales showing well defined bedding planes. No fossils observed. (GPS: 31° 24’ 2.85”S 29° 30’ 52.09”E)

Figure 7.7 Trench into weathered Ecca Group Shales, no fossils were observed. (GPS: 31° 19’ 55.07”S 29° 33’ 53.32”E)
Figure 7.8 Quarry exposing fresh shales of the Ecca Group (GPS: 31° 20' 22.87"S 29° 30' 18.99"E)

Figure 7.9 Typical quarrying into weathered dolerite near proposed Borrow Pit 1 (GPS: 31° 19' 28.44"S 29° 29' 11.79"E)
Figure 7.11 Dolerite outcrop at site of hardrock quarry, Borrow Pit 2 (GPS: 31° 18’ 59.66”S 29° 29’ 3.28”E)

Figure 7.10 Spill way of Zalu Dam underlain by Ecca Group Shales (GPS: 31° 18’ 43.5”S 29° 28’ 30.00”E)
8. PALAEOENTOLOGICAL 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.

No fossils have up to date been recorded from the Natal Group Quartzites or the Alluvium deposits in this area and the dolerite will not contain fossils. A Low Palaeontological sensitivity is allocated to areas underlain by these rocks. Numerous fossils have been described from the Dwyka Formation and Ecca Group in South Africa and there is a possibility of finding fossils in excavation of fresh bedrock in these units. During the field survey it has however been confirmed that both the Dwyka Formation tillite and Ecca Group shales are deeply weathered in the study area and no fossils were recorded during this study. Due to the deeply weathered nature of these units and the fact that no fossils were recorded, a Low Palaeontological sensitivity is allocated to these units. This allocation is mainly based on the assumption that it is unlikely that significant fossil remains will be exposed during excavation of the trenches for the pipelines. The only exception is at the deep excavations that are envisaged for the building of the Zalu Dam wall and the spillway where the ECO must note the possibility of the presence of trace fossils in the Ecca Group sediments.

The palaeontological significance and rating is summarised in Table 8.1 and 8.2 and the Palaeontological sensitivity is shown in Figure 8.1. The methodology for assessing the significance of impacts can be found in Appendix A.
Table 8.1  Palaeontological Significance of Geological Units on Site

<table>
<thead>
<tr>
<th>Geological Unit</th>
<th>Rock Type and Age</th>
<th>Fossil Heritage</th>
<th>Vertebrate Biozone</th>
<th>Palaeontological Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natal Group</td>
<td>Fluvial sandstone and quartzite.</td>
<td>Possible trace fossils</td>
<td>None</td>
<td>Low sensitivity</td>
</tr>
<tr>
<td></td>
<td>SILURIAN?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dwyka Formation</td>
<td>Glacial tillite and shale</td>
<td>Trace fossils, gastropods,</td>
<td>None</td>
<td>Low sensitivity due to deep weathering</td>
</tr>
<tr>
<td></td>
<td>CARBONIFEROUS/PERMIAN</td>
<td>brachiopods and palaeoniscoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fish and plant fossils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecca Group</td>
<td>Deep water shale and fine-grained sandstone PERMIAN</td>
<td>Trace fossils and bivalves – possibly Megadesmus</td>
<td>None</td>
<td>Low sensitivity due to deep weathering</td>
</tr>
<tr>
<td>Dolerite</td>
<td>Dolerite JURASSIC</td>
<td>None</td>
<td>None</td>
<td>Low sensitivity</td>
</tr>
<tr>
<td>Alluvium</td>
<td>Sandy and clayey alluvium</td>
<td>No fossils recorded</td>
<td>None</td>
<td>Low sensitivity</td>
</tr>
</tbody>
</table>

Table 8.2  Significance Rating Table as Per CES Template

<table>
<thead>
<tr>
<th>Rock Unit</th>
<th>Temporal Scale (duration of impact)</th>
<th>Spatial Scale (area in which impact will have an effect)</th>
<th>Degree of confidence (confidence with which one has predicted the significance of an impact)</th>
<th>Impact severity (severity of negative impacts, or how beneficial positive impacts would be)</th>
<th>Overall Significance (The combination of all the other criteria as an overall significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natal Group</td>
<td>Permanent</td>
<td>International</td>
<td>Unsure</td>
<td>No Effect</td>
<td>Slightly beneficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Dwyka Formation</td>
<td>Permanent</td>
<td>International</td>
<td>Possible</td>
<td>Beneficial</td>
<td>Beneficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Slight</td>
<td>Slight</td>
</tr>
<tr>
<td>Ecca Group</td>
<td>Permanent</td>
<td>International</td>
<td>Possible</td>
<td>Beneficial</td>
<td>Beneficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Slight</td>
<td>Slight</td>
</tr>
<tr>
<td>Dolerite</td>
<td>No Impact</td>
<td>No Impact</td>
<td>Definite</td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Effect</td>
<td>No Effect</td>
</tr>
<tr>
<td>Alluvium</td>
<td>Permanent</td>
<td>International</td>
<td>Unsure</td>
<td>No Effect</td>
<td>Slightly beneficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Effect</td>
<td>No effect</td>
</tr>
</tbody>
</table>

Figure 8.1  Palaeosensitivity of the areas affected by the development
9. 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 area is underlain by the Silurian aged Natal Group, Carboniferous to Permian aged Dwyka Formation, Permian aged Ecca Group, Jurassic aged Dolerite and Quaternary aged Alluvium.

Due to the deep weathering of the Dwyka Formation and Ecca Group sediments, a Low Palaeontological sensitivity is allocated to the development. No severe impacts are envisaged and palaeontological mitigation is limited to the ECO noting the possibility of trace fossils on the bedding planes of Ecca Group shales at the wall and spillway of the Zalu Dam.

10. CONCLUSION

The development site for the proposed Lusikisiki Regional Water Supply Scheme, located within the OR Thambo District Municipality in the Eastern Cape is underlain by rocks of the Silurian aged Natal Group, Carboniferous to Permian aged Dwyka Formation, Permian aged Ecca Group, Jurassic aged Dolerite and Quaternary aged Alluvium.

The Natal Group quartzites, Dolerite and Alluvium are not known to contain significant fossils whereas numerous fossils have been described from the Dwyka Formation and Ecca Group in South Africa. In the study area the Dwyka Formation tillites and Ecca Group shales are however very deeply weathered and no fossils were observed in these rocks during this investigation. A Low Palaeontological sensitivity is therefore allocated to all the routes of the pipelines, the reservoir sites and the proposed construction site of the Zalu Dam. Due to the fact that deep excavation of Ecca Group shales is expected at the construction site of the Zalu Dam wall and spillway, it is recommended that the ECO of the project be informed of the possibility that fossils (notably trace fossils) might be present in freshly exposed shales at the construction site of the Zalu Dam wall and spillway. If fossils are reported from these rocks the palaeontologist, Eastern Cape Heritage Authority and SAHRA must be informed and the fossils recorded according to SAHRA specification.

It is recommended that:

3. The ECO of the project be informed of the slight possibility that trace fossils might be exposed on the bedding planes of Ecca Group shales during deep excavations for the construction of the Zalu Dam wall and spillway. If fossils are recorded the palaeontologist, Eastern Cape Heritage Authority and SAHRA must be notified and the fossils recorded according to SAHRA specification.

4. No further mitigation for Palaeontological Heritage needs to be planned for this project.

11. REFERENCES


12. 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 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).

13. 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
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

<table>
<thead>
<tr>
<th></th>
<th><strong>Significance Rating Table</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temporal Scale</strong></td>
<td>(The duration of the impact)</td>
</tr>
<tr>
<td>Short term</td>
<td>Less than 5 years (Many construction phase impacts are of a short duration)</td>
</tr>
<tr>
<td>Medium term</td>
<td>Between 5 and 20 years</td>
</tr>
<tr>
<td>Long term</td>
<td>Between 20 and 40 years (From a human perspective almost permanent)</td>
</tr>
<tr>
<td>Permanent</td>
<td>Over 40 years or resulting in a permanent and lasting change that will always be there</td>
</tr>
<tr>
<td><strong>Spatial Scale</strong></td>
<td>(The area in which any impact will have an affect)</td>
</tr>
<tr>
<td>Individual</td>
<td>Impacts affect an individual</td>
</tr>
<tr>
<td>Localised</td>
<td>Impacts affect a small area, often only a portion of the project area</td>
</tr>
<tr>
<td>Project Level</td>
<td>Impacts affect the entire project area</td>
</tr>
<tr>
<td>Surrounding Areas</td>
<td>Impacts affect the area surrounding the development</td>
</tr>
<tr>
<td>Municipal</td>
<td>Impacts affect either the Local Municipality, or any towns within them</td>
</tr>
<tr>
<td>Regional</td>
<td>Impacts affect the wider district municipality or the province as a whole</td>
</tr>
<tr>
<td>National</td>
<td>Impacts affect the entire country</td>
</tr>
<tr>
<td>International/Global</td>
<td>Impacts affect other countries or have a global influence</td>
</tr>
<tr>
<td>Will definitely occur</td>
<td>Impacts will definitely occur</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th></th>
<th><strong>Impact severity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(The severity of negative impacts, or how beneficial positive impacts would be on a particular affected system or party)</td>
</tr>
<tr>
<td><strong>Very severe</strong></td>
<td>An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example the permanent loss of land.</td>
</tr>
<tr>
<td><strong>Very beneficial</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Beneficial</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Moderately severe</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Moderately beneficial</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Slight</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Slightly beneficial</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>No effect</strong></td>
<td>The system(s) or party(ies) is not affected by the proposed development.</td>
</tr>
<tr>
<td><strong>Don’t know/Can’t know</strong></td>
<td>In certain cases it may not be possible to determine the severity of an impact</td>
</tr>
</tbody>
</table>
## Table 3: Overall significance appraisal

<table>
<thead>
<tr>
<th>Overall Significance</th>
<th>(The combination of all the above criteria as an overall significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VERY HIGH NEGATIVE</strong></td>
<td><strong>VERY BENEFICIAL</strong></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: The loss of a species would be viewed by informed society as being of VERY HIGH significance.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: 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.</td>
<td></td>
</tr>
<tr>
<td><strong>HIGH NEGATIVE</strong></td>
<td><strong>BENEFICIAL</strong></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: 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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: 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.</td>
<td></td>
</tr>
<tr>
<td><strong>MODERATE NEGATIVE</strong></td>
<td><strong>SOME BENEFITS</strong></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.</td>
<td></td>
</tr>
<tr>
<td><strong>LOW NEGATIVE</strong></td>
<td><strong>FEW BENEFITS</strong></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: The temporary change in the water table of a wetland habitat, as these systems is adapted to fluctuating water levels.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: 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.</td>
<td></td>
</tr>
<tr>
<td><strong>NO SIGNIFICANCE</strong></td>
<td></td>
</tr>
<tr>
<td>There are no primary or secondary effects at all that are important to scientists or the public.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: 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.</td>
<td></td>
</tr>
<tr>
<td><strong>DON’T KNOW</strong></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Example</strong>: The effect of a particular development on people’s psychological perspective of the environment.</td>
<td></td>
</tr>
</tbody>
</table>