Palaeontological Impact Assessment (Phase 1) for the proposed Mpuphusi River sand winning, Nongoma Local Municipality (KZN265), Zululand District, northern KwaZulu-Natal

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TABLE OF CONTENTS

1. Introduction.……page 3

2. Geology.……page 5

3. Palaeontology……page 7

4. Archaeology……page 11

5. Field observations and recommendations……page 12

6. Contingency plan for possible fossil discoveries……page 12

7. Assumptions and limitations……page 13

8. References……page 14

FIGURES

Figure 1: SAHRIS PalaeoSensitivity Map……page 5

Figure 2: Geology of the region surrounding proposed sand mining site……page 7

Figure 3: Satellite image showing outline of proposed sand mining site……page 8

Figure 4: Bedrock exposed to the South-West of the site……page 9

Figure 5: Bedrock exposed to the North of the site……page 9

Figure 6: Stratified sediments within river embankment……page 10

Figure 7: Prepared core showing calcrete encrustation……page 11

Figure 8: Prepared core showing calcrete encrustation……page 11

1. Introduction

In terms of the National Environmental Management Act 107 of 1998, Section 38 (8) of the National Heritage Resources Act 25 of 1999, and the KwaZulu-Natal Heritage Act 4 of 2008, all aspects of cultural heritage are protected and proposed developments that are likely to impact on any and all facets of heritage (i.e. historical, archaeological, palaeontological & cosmological) require a desktop study and/or field assessment in order to gauge the nature of potential heritage resources and to ensure that such resources are not damaged or destroyed through the activity which threatens them. If necessary, mitigation measures should be considered and if the observed heritage resources are ranked as highly significant and the proposed location cannot be shifted to a more suitable site, scientific researchers should be given the opportunity to excavate the site and recover as much of the material as possible.

The Mandlakazi Bulk Water Supply Scheme is a bulk pipeline installation extending from the Pongolapoort Dam to various rural villages in the region, comprising bulk and secondary bulk pipelines and associated chambers totaling approximately 144 kilometres in length. Suitable bedding material is required within the pipeline trenches to form a protective barrier below, above and surrounding the pipeline. This material also facilitates drainage of rainwater and prevents waterlogging within the trenches. The alluvial sands adjacent to the Mpuphusi River were found to be suitable for pipe bedding as they are free of clay and have the appropriate qualities required for the job. The proposed sand mining site is situated 2.5 kilometres west of KwaNcongoma, within the Nongoma Local Municipality and will cover an area of approximately 4.9 hectares (Figure 3). The proposal also includes a Water Use Licence Application (in terms of the National Water Act No.36 of 1998) as the sand winning

triggers Section 21 (*c*), *Impeding or diverting the flow of water in a watercourse*, and, (i) *Altering the bed, banks, course or characteristics of a watercourse*.

The area of the proposed sand mining site is given a green (moderate) palaeo-sensitivity rating (Figure 1); therefore a desktop Palaeontological Impact Assessment was required before the development could go ahead. Although these Quaternary deposits have a moderate rating, the site is situated within a region where the underlying bedrock has a red (very high) palaeo-sensitivity ranking. Furthermore, just to the east of the site is the contact between the Emakwezini Formation (**Pem**) and the Vryheid Formation (**Pv**) of the Ecca Group, both of which are known to be fossil-bearing (Figure 2).

The study was carried out using a combination of Google Earth, geological maps, the SAHRIS PalaeoSensitivity map, a database of all known fossil sites in South Africa, published journal articles on the geology of the region, South African legislation pertaining to heritage and a field survey.

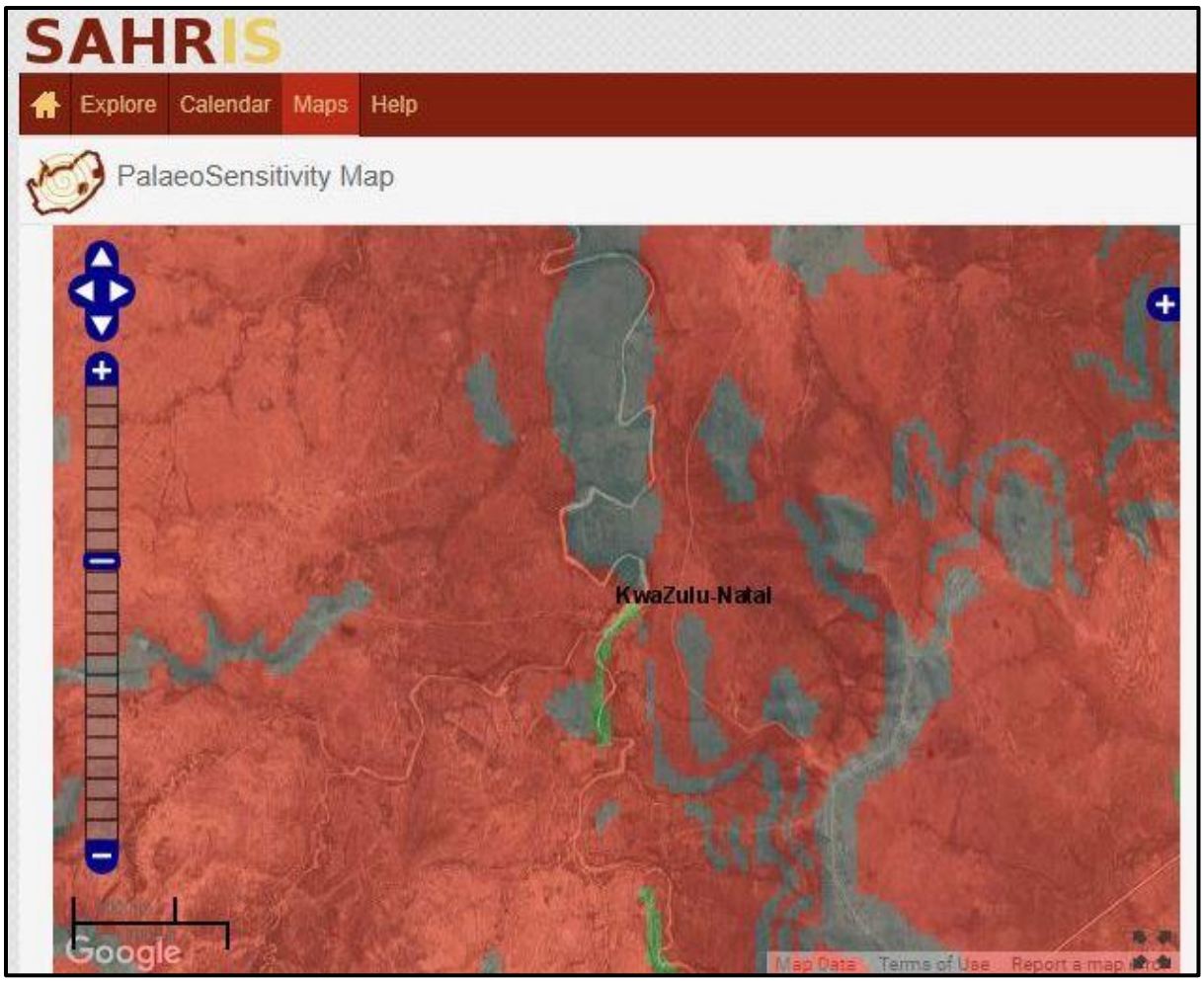

Figure 1: The SAHRA PalaeoSensitivity map, depicting a satellite image of the proposed sand mining site overlain with a colour-coded layer indicating the likelihood of fossil occurrences. The area is highly sensitive area (red), with small patches of green (moderate sensitivity) and patches of grey (dolerite) which have a zero sensitivity rating as these rocks are non-fossiliferous (Modified from the SAHRA PalaeoSensitivity map, www.sahra.org.za/sahris/map/palaeo)

2. Geology

The underlying geology in the vicinity of the proposed sand mining site is dominated by Late Permian argillaceous deposits of the Ecca Group (Figure 2). The Ecca Group represents deposits which accumulated as (predominantly) fine-grained sediments along the floor and edges of a giant inland sea, which was fed by several rivers representing a complex system of thriving palaeo-ecosystems. The fluvial processes of this system later gave rise to the siltstones, mudstones and sandstones of the Emakwezini Formation.

These lowermost Ecca shales are representative of the Pietermaritzburg Formation (**Pp** on map) which are dark-grey to black in colour, with thin stratigraphic units of siltstone and subordinate sandstone in the upper part of the sediment package (Tavener-Smith 1981, Tankard *et al.* 1982, Visser 1992). This rock type is known to be fossil-bearing, containing marine fossils at its base where it is underlain by diamictites of the Dwyka Group. Fossils from the Pietermaritzburg Formation include the trace fossil *Skolithos* found at the site of Newlands Estate, Durban (Tavener-Smith 1980).

Sitting above the Pietermaritzburg Formation is the Vryheid Formation (**Pv**), which is the most extensive of the Ecca deposits within the region, comprising of sandstone, shale and grit with coal and oil-shale beds. Therefore the possibility exists that plant fossils may be present within this geological unit, hence why it has a palaeo-sensitivity rating of very high (red). The Volksrust Formation (**Pvo**) sits above the Vryheid Formation and is limited to a small patch within the study area. It has a high palaeo-sensivity rating (orange), with the deposits comprising layers of shale and siltstone.

The Beaufort Group is represented by the Emakwezini Formation (**Pem**) which comprises sandstone, siltstone and shale with thin coal seams. This unit has a very high palaeo-sensitivity rating (red). There are also several outcrops of dolerite in the region, representing Jurassic lava that intruded into older rocks approximately 150-160 million years ago, giving rise to the dolerite dykes in the landscape (**Jd** on map). Being volcanic, these rocks represent a sterile geological unit in terms of fossil occurences. Considerably younger (< 2.5 million) Quaternary alluvial deposits (**Qm**) occur alongside many of the drainage lines of the lower lying areas and include gravel beds, clay, top soil, laterite and silcrete. These (predominantly) channel and overbank deposits may harbour archaeological and palaeontological material as water will always attract human and animal activity.

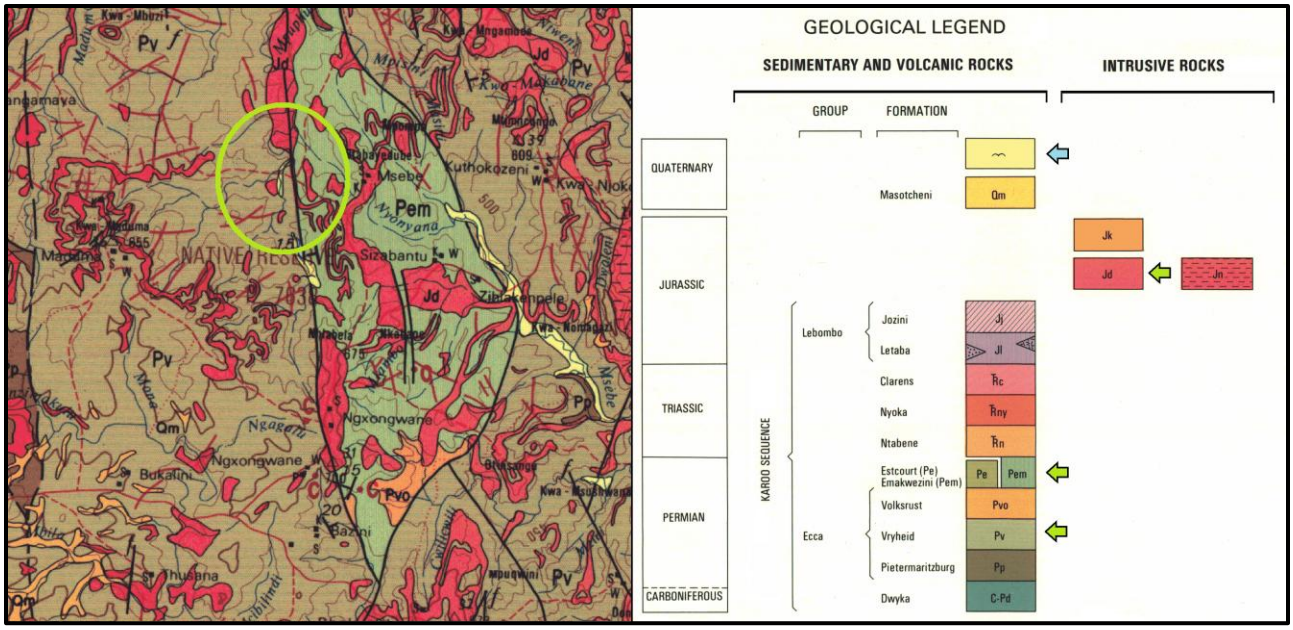

Figure 2: Geology of the region surrounding the proposed sand mining site. The **Ecca Group** is the most abundant geological unit in the area and has elements of the Pietermaritzburg (**Pp**), Vryheid (**Pv**) and Volksrust Formations (**Pvo**). The **Beaufort Group** is represented by the Emakwezini Formation (**Pem**) which comprises sandstone, siltstone and shale with thin coal seams. Large outcrops of intrusive lavas exist in the form of dolerite (**Jd**). Quaternary deposits occur along several of the large drainages and include reworked sands, gravel beds, clay, top soil, laterite and silcrete. The blue arrow indicates these younger deposits, of which the shifting reworked sand banks are proposed for mining. It is recommended that the vegetated stratified riverbanks to the east of the proposed site be left intact as these may contain younger archaeological material. The green arrows indicate bedrock present in the study area whereas the green circle indicates the general area where the proposed sand mining will take, a place where the Ecca (**Pv**) meets the Beaufort (**Pem**). North is at the top of the page (Modified from 2730 Vryheid, 1:250 000 Geological Series, Geological Survey, Pretoria, 1988)

3. Palaeontology

During the survey sections of exposed bedrock were noted on the way down to the river, as well as to the North and South-West of the site (Figures 3-5). None of these exposures were in the immediate vicinity of the proposed sand mining site but nonetheless were examined for possible fossil evidence and none was found. Other locations in the landscape which may preserve fossil occurrences include patches of Quaternary deposits, which are mainly comprised of the channel and floodplain deposits of rivers in the low-lying areas (Figure 6). Water will attract animals and humans, therefore theoretically alluvial deposits are likely to contain archaeological and palaeontological material. Every time there is a flood event,

overbank deposits will bury any such material lying adjacent to the river. Eventually the overbank deposits become stratified, indicating multiple flood and soil formation processes. The deeper such deposits are, and the more varied the colours of the stratified sediments, the greater the age. Figure 6 indicates that the overbank deposits are stratified and contain established riparian vegetation. The colours of these stratigraphic units are different, indicating that the riverbank formed over a period of time but is likely to be geologically young. Even though these stratified deposits may contain younger archaeological and/or palaeontological material, this area will not be targeted for mining as only the loose sand within the riverbed will be utilised.

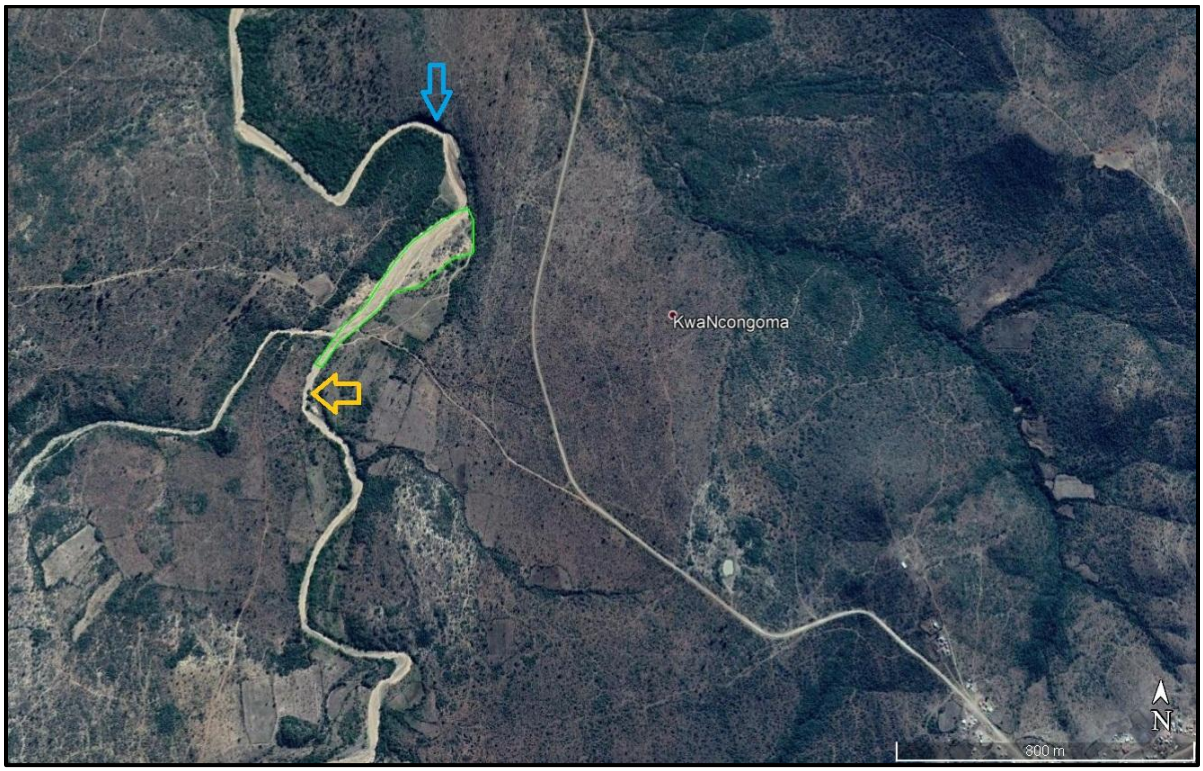

Figure 3: Satellite image of the proposed sand mining site, the boundaries of which are indicated in green. The blue and yellow arrows point to the locations of the exposed bedrock to the N and SW of the site, pictured in Figure 4 & 5 (Modified Google Earth Image, DigitalGlobe 2018)

Figure 4: Exposed Ecca bedrock (Vryheid Formation) to the SW of the proposed sand mining site (yellow arrow in Figure 3)

Figure 5: Ecca bedrock (Vryheid Formation) found to the North of the site, indicated with a blue arrow in Figure 3

Figure 6: The eastern riverbank shows evidence of stratification, highlighted with the coloured lines. These represent flood events and soil formation processes, evidence that this embankment may be hundreds or even thousands of years old and may therefore contain archaeological and/or palaeontological material trapped within the layers

The sands proposed for mining are highly mixed, geologically young and are redeposited every time the water level rises and has sufficient energy to move this material. From experience gained through previous surveys, such material is generally absent of archaeological and/or palaeontological specimens. If present, such material is out of context; very rolled and smoothed through the weathering action of the water and sand; and fragmentary. Karoo fossils may wash downstream and become incorporated into these young sands, but such material is generally undiagnostic; dominated by petrified wood fragments; and of little value to science. Although unlikely to contain fossils, these deposits were thoroughly surveyed but no evidence of palaeontological material was observed within these unconsolidated riverbed sediments.

4. Archaeology

During the survey, a prepared core (Figures 7 & 8) was discovered on the way down to the sand mining site (GPS co-ordinates S 27° 48′33.3″ E 31° 46′ 31.4″). This artefact was only a few hundred metres from the river and its method of manufacture resembles that of a Middle Stone Age core, although it exact age would be difficult to determine. A useful clue preserved on the surface of this core is calcrete, a calcium carbonate deposit which greatly assists with the fossilization of bone (green arrow in photos). Thin layers of this mineral were also noted in several of the bedrock exposures in the region. The presence of this mineral in the soil and within the bedrock suggests that Quaternary fossils may also be present in the landscape. Although this core had eroded out of the sedimentary layer it was originally deposited in, it provides evidence that Quaternary fossilization is possible within this valley.

Figure 7 & 8: A prepared core found close to the Mpuphusi River. The surface of the core is covered with patches of calcrete, some of which occur on the cortex whilst others are located on the flake scars (green arrows). This indicates that the calcrete deposition occurred after the rock had been flaked and not whilst it was an unmodified, natural stone in the soil. This is a useful clue to the fact that fossilization is possible within these Quaternary deposits as dissolved calcium carbonate in ground water can penetrate bone and later crystallize into calcrete, thus fossilizing the bone

5. Field observations and recommendations

Where there is water activity such as springs or streams and associated alluvial deposits, there is always a possibility that such deposits could harbour evidence of human and animal activity. During the survey the loose sands of the proposed site, the stratified riverbank, as well as the exposed bedrock along the verge of the river were all investigated to ascertain the possibility of fossil occurrences. However, due to the nature of these shifting sands, the possibility of encountering well-preserved important fossil material is minimal. In spite of rigorous searching, no palaeontological material was observed within the sand deposits during the field survey.

In conclusion, Quaternary fossils may occur in the region and some of these may lay buried within the stratified riverbank adjacent to the proposed sand mining site, but based on the observations of the survey the mining can proceed. If material is uncovered which looks fossil-like, construction should immediately cease, with the correct process to follow outlined in the contingency plan below. Disturbance to riparian vegetation growing on the stratified riverbanks should be minimized and stabilisation of river embankments encouraged so as to prevent the erosion of sediments which may contain archaeological and/or palaeontological material.

6. Contingency plan for possible fossil discoveries

The normal procedure for recovering palaeontological material would be to identify areas which are dense in fossils and whose recovery and preparation could address certain scientific questions, especially if they are ranked as significant specimens which are likely to make a positive contribution to the field of palaeontology. The process would then entail

obtaining permission from the landowner/s and applying to SAHRA (South African Heritage Resources Agency) to obtain an excavation permit.

However, the likelihood of finding fossils within the uncompacted sands of the riverbed is low. If present they will be out of context, fragmentary and poorly preserved due to the weathering action of the water and abrasive nature of the sand. Furthermore, these sands are highly mobile during the rainfall season when raised water levels transport it over great distances, making it almost impossible to pinpoint where potential fossil specimens originated from. As mentioned above, sand banks within the riverbed are continuously shifting and mined sand will soon be replaced during high water levels, with time re-establishing the natural characteristics of the watercourse. Over time, this depositional action of the river has the potential to negate the resulting disturbance caused to the watercourse, as highlighted in Section 21 (*i*) of the National Water Act (No.36 of 1998).

As on-site screening of tons of channel deposits will be taking place, obvious fossil material (if present) will remain behind with the gravel, pebbles and stones. If observed, these specimens should be kept aside and not returned to the river channel. This will not slow or hinder the progress with the sand mining but will instead present an opportunity for recovered palaeontological material to make its way to a museum or university. Therefore, if by chance fossils were discovered, a protocol should be followed whereby the relevant heritage custodians in KwaZulu-Natal (Natal Museum or Amafa) would need to be informed.

7. Assumptions and limitations

According to the amended 2017 EIA regulations, various assumptions and limitations need to be stated when reporting on proposed developments. The professional opinion given in this PIA report is based on the results of a field survey which was used to gauge the fossiliferous potential of riverbed sands. As a general rule, field observations are based on recording

palaeontological and/or archaeological material which is eroding out or visible on the surface. As many developments require a degree of digging down into the soil and/or underlying stratigraphy, heritage objects will only be exposed once they have been disturbed from their original positions. Therefore such objects would have been hidden from the assessor during the fieldwork survey.

8. References

1) KwaZulu-Natal Heritage Act 4 of 2008

2) National Environmental Management Act 107 of 1998

3) National Heritage Resources Act 25 of 1999, Section 38 (8)

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7) Visser, J.N.J., 1992. Sea-level changes in a back-arc-foreland transition: the late Carboniferous-Permian Karoo Basin of South Africa. *Sedimentary Geology* (83), 115-131