# Palaeontological Impact Assessment for the proposed Mandlakazi bulk water supply scheme, Phase 5, Nongoma Local Municipality, Zululand District, northern KwaZulu-Natal

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**Masters in Environmental Management, UFS**

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## TABLE OF CONTENTS



## FIGURES

# 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.

Due to increased water requirements in the region, the Zululand District Municipality is implementing the Mandlakazi Phase 5 bulk water pipeline project. This development will utilize water sourced from the Pongolapoort dam to provide a reliable potable water supply to the villages situated in a mountainous region approximately 20 kilometres south-west of the town of Mkuze and about 15 kilometres east of the town of Nongoma, northern KwaZulu-Natal (Figure 1). The project involves the upgrade of the existing Mandlakazi Water Treatment Works from 2Mℓ per day to 20Mℓ per day; the construction of bulk and secondary bulk pipelines and associated chambers totaling approximately 144 kilometres in length and ranging from DN 350 to DN 100mm in diameter; the construction of approximately 28 reservoirs ranging in size from 4Mℓ down to 50Kℓ; the construction of two pump stations; and lastly the proposed Mandlakazi Water Purification works.

The area of the proposed development is situated within a region which has a very high palaeo-sensitivity rating; therefore a Palaeontological Impact Assessment was required before the development could go ahead. 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 of the geology of the region, South African legislation pertaining to heritage and a thorough field survey.


Figure 1: Satellite image showing the broader region surrounding the proposed pipeline. The area marked in red indicates the extent of the development, with the external red layer serving as an outline of the area of the project whereas the internal red lines indicate all the branches of the pipeline and the dams they will be connected to. The Pongolapoort dam is the source of the water for the pipeline, indicated with a blue arrow. The town of Mkuze is given as a reference point, situated just south of the Pongolapoort dam. Viewed from an elevation of about 100km, North is at the top of the page (Modified Google Earth image, AfriGIS, 2018)

# 2. Geology

The geology of the landscape in the vicinity of the proposed pipeline includes some of the most basal sediment packages of the Karoo basin in the form of the Dwyka Group (**C-Pd**), comprising tillite, subordinate varved shale and dropstone-bearing shale and sandstone. These rocks represent sediments accumulated as a result of material released from melting glaciers and have a moderate palaeo-sensitivity rating (green). The underlying geology in the area of the proposed pipeline is dominated by late Permian argillaceous deposits of the Ecca Group (Figure 2). 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 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 (**Pv**) Formation, 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 and this is also the reason 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 of 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 150-180 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.

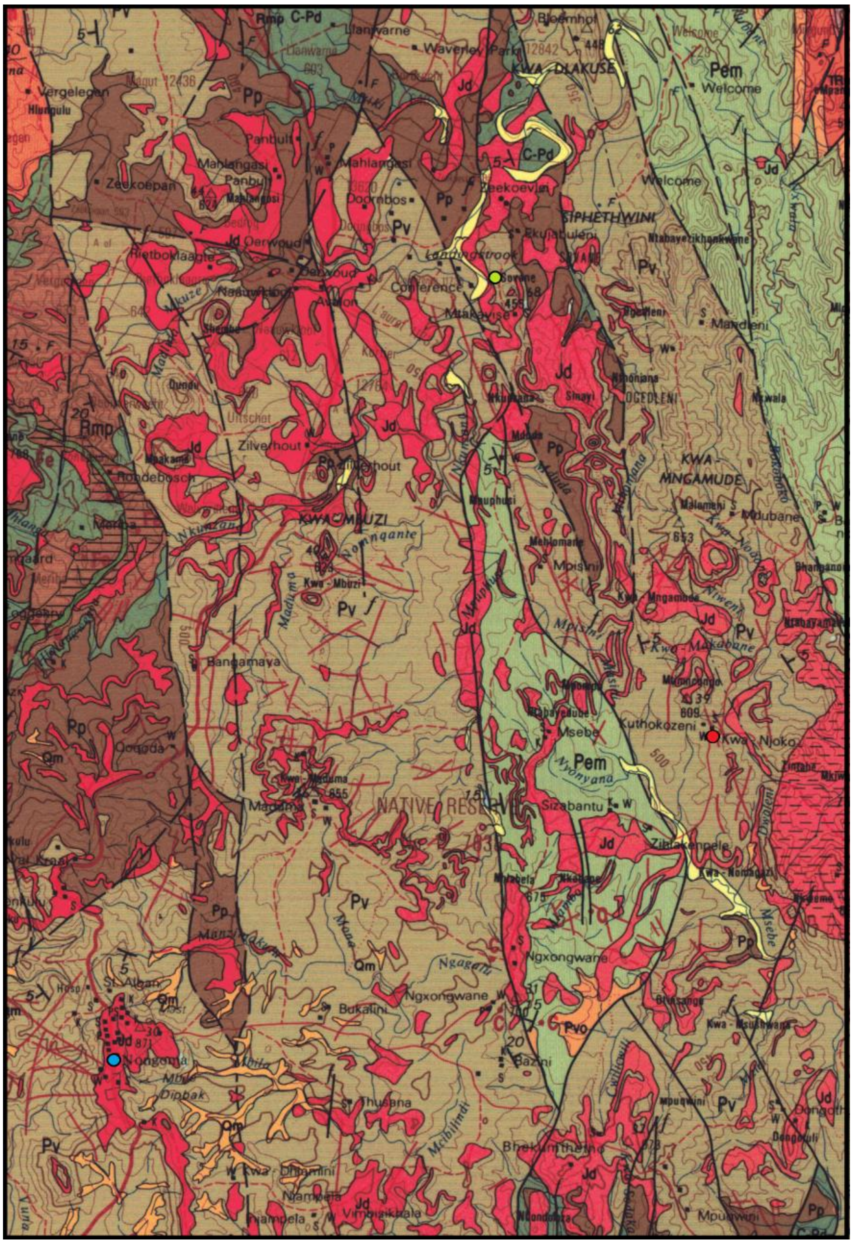


Figure 2: Geology of the region surrounding the proposed pipeline project. The geology includes some of the most basal sediment packages of the Karoo basin in the form of the **Dwyka Group** comprising tillite, subordinate shale and dropstone-bearing shale and sandstone. The **Ecca Group** is the most abundant geological unit in the region 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 dolerites (**Jd**). Quaternary deposits occur along several of the large drainages and includes gravel beds, clay, top soil, laterite and silcrete (**Qm**) Sovane is indicated with a lime-green dot, Nongoma with a blue dot and Njoko with a red dot. North is at the top of the page (Modified from 2730 Vryheid, 1:250 000 Geological Series, Geological Survey, Pretoria, 1988)

## 3. Palaeontology

The Ecca Group represents Late Permian deposits which accumulated as (predominantly) fine-grained sediments along the floor 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 gave rise to the siltstones, mudstones and sandstones of the Beaufort Group. SAHRA has given this area a palaeontological sensitivity rating of very high (indicated as red) with small patches which have a high rating (orange) while other sections have a moderate rating (green). The areas marked with grey indicate dolerite outcrops and have a zero sensitivity rating (Figure 3 & 4, also see www.sahra.org.za/sahris/map/palaeo)

During the survey all sections of exposed bedrock were examined for possible fossil evidence but none was found. One rock which had been moved from its original position due to the creation of a previous sand road displayed tunnel-like grooves which superficially resemble animal burrows (GPS co-ordinates S 27° 44′ 40.20″, E 31° 50′ 04.89″, Figure 13). Although resembling a trace fossil, these patterns are likely the result of the erosive action of flowing water and the scouring effect of river pebbles.

Besides bedrock, other possible 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. Water will attract animals and humans, therefore theoretically alluvial deposits are likely to contain archaeological and palaeontological material. Instances where the path of the pipeline crosses over rivers and/or streams or runs parallel to them within their floodplain zone could potentially pose a risk to buried fossils within these areas. However, Quaternary deposits are not abundant in this area and no evidence of fossils was observed within these younger sediments.

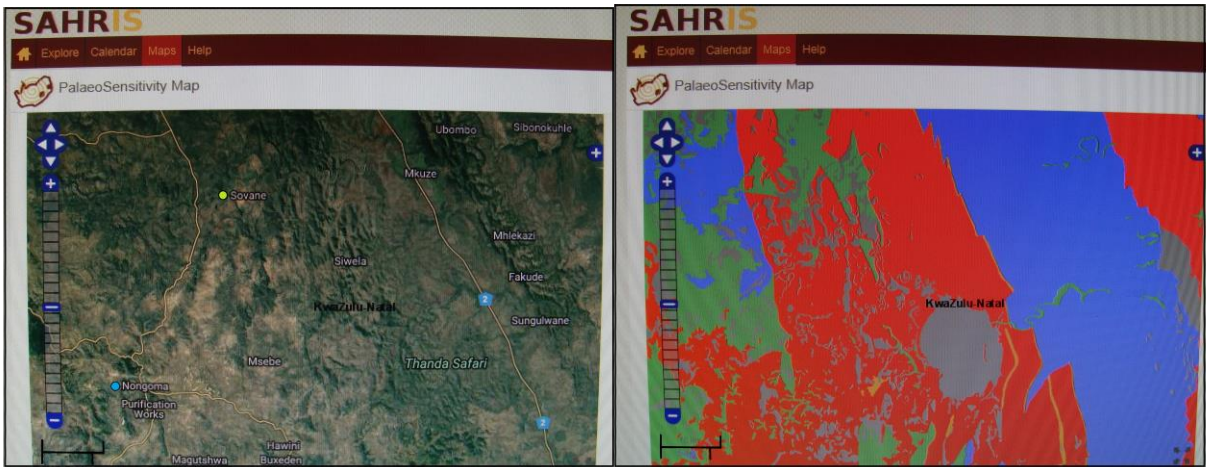


Figure 3 & 4: The SAHRA PalaeoSensitivity map, depicting a satellite image of the region of the proposed development with the palaeo-sensitivity switched off (left) and the same region with the palaeo-sensitivity switched on (right). Large parts of the pathway of the pipeline occur in a highly sensitive 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)

## 4. Archaeology

During the survey, only three locations were recorded where stone tools were present. One comprised of a single flake with a facetted platform, indicating that it likely originates from the MSA as this method of flaking from a prepared core was not used in the LSA. The flake was found adjacent to a shallow quarry and was probably dislodged from its original position when material was being sourced from the pit (GPS co-ordinates S 27° 44′ 26.95″, E 31° 49′ 07.86″). Another stone tool occurrence which was recorded during the survey comprised of several flakes and two cores which appear to originate from the LSA (Figures 39 & 40). At this same location, thick-walled pottery fragments (Figure 41) were observed and may date back to the Iron Age (GPS co-ordinates S 27° 50′ 59.10″, E 31° 42′ 26.28″). Additional thick-walled pottery fragments were found adjacent to the graveyard at GPS coordinates S 27° 53′ 32.60″, E 31° 47′ 08.72″, observed along the road leading up to the cell phone tower (Figures 45 & 46). The last site containing stone artefacts included an upper grindstone (Figure 24) and a core (Figure 25) found at GPS co-ordinates S 27° 48′ 35.4″ E 31° 46′ 35.0″ and S 27° 48′

33.3″ E 31° 46′ 31.4″ respectively. Several graves were also recorded during the survey, which are summarised in the Pongola Pipeline kml file.

## 5. Field observations and recommendations

During the survey, all quarries that occurred along the route of the proposed pipeline were investigated to record the stratigraphy present and to ascertain the possibility of fossil occurrences. The same process was followed where anthropogenic road cuttings or natural erosive processes had exposed the bedrock along the verge of the road. In spite of rigorous searching, no palaeontological material was observed within these quarries or road-cuttings. However fossils are not always highly visible when the stratigraphy in question is viewed from the side, which was how the majority of these layers were exposed within the quarries and road cuttings. As they are trapped within sedimentary layers, fossils are most easily observed when parallel sheets of rock are removed from above to reveal the fossils trapped between successive layers. Throughout the entire survey, only one patch of rocks presented features which resembled trace fossils in the form of burrows or tunnels. However these represent attributes of water erosion which superficially resemble burrows. These rocks were loose and out of context of the sedimentary sequence they originated from as they appear to have been moved during earlier road construction.

The fossiliferous Ecca and Beaufort Formations are partially shielded by overlying younger sediments comprised of a mixture of top soil, decomposed bedrock, colluvium and in some cases alluvium. This layer may function as a kind of buffer protecting underlying palaeo-sensitive rocks from human activity at the surface. However, it was noted during the survey that this layer of top soil varied in depth and may contain archaeological material including lithics and pottery as humans have been using this landscape for tens of thousands of years.

Where there is water activity such as springs or streams and associated alluvial deposits, there is a possibility that these deposits could harbour evidence of human and animal activity. Although archaeologically sensitive, no Quaternary fossils were observed within this layer during the field survey. While this stratum of top soil can function as a kind of protective cushion, the depth of the trench for the pipeline will, for the most part, extend beyond this buffered layer and the heavy earth-moving equipment will likely break through into the potentially fossiliferous bedrock in several places. Therefore the path of the pipeline will unavoidably extend into this layer, but based on what was observed within roadside cuttings; exposed bedrock on the verge of the road; and within quarries along the route, fossils appear to be a rare occurrence and challenging to locate within this geological setting. The section of pipeline where fossils are most likely to be encountered (if present) is the stretch that runs from Odushwini east towards Mpungwini (Figures 50-54). The site foreman and engineer need to be cautious and observant of exposed bedrock along this section as the survey indicated that these stratigraphic units could potentially harbour fossiliferous material. If any such material is encountered, construction would need to cease immediately and points discussed in Section 6 would need to be considered.

In terms of encountering potential fossils in the younger alluvial deposits, caution should be exercised when digging the trench for the pipeline between GPS co-ordinates S 27° 43′ 43.06‴ E 31° 45′ 47.00″ and S 27° 43 ′43.48″ E 31° 45′ 45.76 ″and between GPS point S 27° 48′ 29.27″ E 31° 46′ 27.70″ and point S 27° 48′ 23.99″ E 31° 46′ 16.19″. These two sections cross the floodplain of the river and may therefore contain fossils trapped within the channel and overbank deposits. The drivers operating the heavy earth moving equipment along these zones should be informed about the potentially palaeo-sensitive nature of the material being excavated and the site foremen should be vigilant of the objects coming to the surface as they may represent faunal skeletal elements.

In terms of graves, there are several points where the path of the pipeline comes within metres of graves, and even at one point crosses straight through a graveyard (GPS co-ordinates S 27° 56′ 28.91″ E 31° 50′ 36.10″). The engineers will need to slightly modify the route along these sections so as to create a sufficient buffer zone around these culturally sensitive features. All graves mapped within the search area are presented within the kml file, along with other features such as quarries, archaeologically and palaeontologically sensitive areas and stratigraphic observations.

In conclusion, fossils may occur in the region and some of these may lay buried along the route of the proposed development (using the SAHRA palaeo-sensitivity map as a guideline), but based on the observations of the survey the building of the pipeline can proceed as the possibility of encountering fossil material during the construction process seems to be minimal. An examination of all fossil databases for South Africa housed at the Evolutionary Studies Institute at Wits University also revealed that there are no fossil records from this region, although this does not mean that they are not present but rather that insufficient research has been conducted within this rural landscape. If material is encountered that looks fossil-like, construction should immediately cease, with the correct process to follow being outlined in the contingency plan below.

## 6. Contingency plan for possible fossil discoveries

As explained above, the likelihood of finding fossils along the route of the proposed pipeline in low. Furthermore, an existing pipeline and its associated reservoirs already exists along several of the proposed routes, indicating that the stratigraphy has previously been disturbed during the construction of this older network. Another aspect to consider is that the shale and sometimes also the siltstone of the Ecca bedrock is very often crumbly and extremely difficult to recover fossils from. There is a greater chance of recovering fossils from the

Beaufort Formation, but this unit only occurs in a small patch within the centre of the project area. 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. The process would then entail obtaining permission from the landowner/s and applying to SAHRA (South African Heritage Resources Agency) to remove blocks of bedrock and prepare them with a pressured rock drill in the lab.

This is a slow and time-consuming process which requires the skills of a field palaeontologist to spot worthy material within rock exposures and a qualified fossil preparator who can successfully recover fossils from slabs of (very often) unstable bedrock. Therefore, the probability of construction workers who are operating heavy earth moving equipment and working to a strict time schedule (and the on-site foremen) spotting fossils amongst tons of bedrock is unlikely. If fossils are present, they may be difficult to identify as many geological formations superficially resemble palaeontological material. Pseudo-fossils such as concretions, nodules, dendrites, calcrete and other mineral deposits often form into a variety of shapes which may closely resemble plant and animal fossils, making it more difficult for laypersons to positively identify chance finds in the field.

If by chance fossils were discovered, construction would need to cease immediately and a protocol should be followed whereby the relevant heritage custodians in KwaZulu-Natal (Natal Museum or Amafa) would need to be informed. Developers would also need to acquire the services of a palaeontologist to conduct a field assessment so that if anything relevant is discovered the necessary mitigation measures could be implemented and scientists could be given the opportunity to record and/or recover the specimens if they are ranked as significant and likely to make a positive contribution to the field of palaeontology.

## 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 the bedrock likely to be exposed during the proposed development. 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.

Furthermore, as mentioned in the text above, fossils are not always easy to spot when they are have not yet started eroding out and when the stratigraphy they are preserved in is viewed from the side. Therefore the ideal situation would be to be present when earth-moving equipment is peeling off layers of bedrock from above as the exposed fossils will be more visible when overlying sheets are removed. In addition, the results reported herein are based upon a thorough field survey and careful scrutiny of the best available maps and data sets and all attempts were made to take a holistic, informed decision. Yet in spite of this, it is possible that fossils may be present somewhere along the route of the proposed pipeline but are hidden from view due to their buried nature. Moreover, certain predictions about the likelihood of encountering fossils was based on all available evidence and may prove to be less or more likely than anticipated .

Furthermore, it is assumed that the developers will respect the guidelines set out in the laws of South Africa with regards to good environmental management practices and policies, and will immediately cease all construction if any fossiliferous material is discovered. It is also assumed that developers will practice integrity and embrace an unwavering mind-set with regards to respecting and protecting all aspects of heritage, including due consideration for the fact that such objects cannot simply be sacrificed to meet project deadlines.

## 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)

4) Tankard, A.J., Jackson, M.P.A, Eriksson, K.A., Hobday, D.K., Hunter, D.R. & Minter, W.E.L., 1982. *Crustal evolution of Southern Africa*. Springer Verlag, New York, 1523 pp.

5) Tavener-Smith, R., 1980. The *Skolithos*-bearing sandstone at Newlands Estate, Durban: A suspected shallow water, offshore sand-tongue in the Lower Ecca Group (Pietermaritzburg Formation). *Transactions of the Geological Society of South Africa* (83) 87-91

6) Tavener-Smith, R., 1981. Prograding coastal facies associations in the Vryheid Formation (Permian) at Effingham quarries near Durban, South Africa. *Sedimentary Geology* (32), 111-140

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

# 9. Appendix

Figure 5: Stratigraphic section exposed on the side of the road and labelled “stratigraphy on bend” on kml file. The rocks comprised of shale and siltstone, with a white band of sandstone which had shale above and below it

Figure 6: Further depictions of the stratigraphy at the point labelled “stratigraphy on bend”. The rocks comprised of siltstone and shale, with nodules of calcrete embedded within the shale.

Figure 7: In spite of a thorough examination of the rocks, no fossils were observed at the point “stratigraphy on bend”. Depicted is siltstone sitting on shale

Figure 8: At “stratigraphy on bend” several calcrete nodules were noted within the shale

Figure 9: Graves observed on the side of the road close to the route of the proposed pipeline (GPS co-ordinates S 27° 45′ 18.67″ E 31° 49′ 52.84″)

Figure 10: More graves observed along the route of the pipeline, GPS co-ordinates S 27° 45′ 25.45″ E 31° 49′ 51.93″

Figure 11: When examining the exposed bedrock anything resembling fossil material was carefully scrutinized. In this case the material turned out to be calcrete within the siltstone

Figure 12: Photograph taken on the way up to the top of the hill where one of the proposed reservoirs will be located (GPS co-ordinates S 27° 45′ 28.27″ E 31° 49′ 37.64″). Note the quarry next to the car. All such features where bedrock was exposed were searched for any possible traces of fossil material to gauge what could lay hidden beneath the surface

Figure 13: Features preserved on a sandstone rock which superficially resemble trace fossils in the form of burrows. However these patterns are natural and probably represent potholes and scouring marks from river pebbles (GPS co-ordinates S 27° 44′ 40.37″ E 31° 50′ 04.84″)

Figure 14: Stratigraphy exposed on the side of the road at S 27° 44′ 24.16″ E 31° 50′ 49.67″ revealing laterite and clay sitting on top of sandstone

Figure 15: View from the top of the hill where one of the proposed reservoirs will be built (GPS co-ordinates S 27° 50′ 32.9″ E 31° 52′ 01.6 ″)

Figure 16: Situated very close to where this proposed reservoir will be built are several graves (GPS co-ordinates S 27° 50′ 30.23″ E 31° 52′ 01.53″)

Figure 17: Stratigraphy on the side of the road revealing sandstone interspersed with layers of shale (GPS co-ordinates S 27° 49′ 07.02″ E 31° 49′ 59.70″)

Figure 18: Zoomed in view of wall of roadside stratigraphy showing calcrete in shale (GPS co-ordinates S 27° 49′ 07.02″ E 31° 49′ 59.70″)

Figure 19: Layers of siltstone and shale, showing how the siltstone is more resistant to weathering (ridges) and the shale more prone to it (slopes) GPS co-ordinates S 27° 49′ 43.11″ E 31° 49′ 12.32″

Figure 20: Thick sediment package of siltstone with topsoil layer above it (GPS co-ordinates S 27° 49′ 43.11″ E 31° 49′ 12.32″)

Figure 21: Stratigraphy at roadside depicting shale on sandstone (GPS co-ordinates S 27° 49′ 56.1″ E 31° 47′ 49.3″)

Figure 22: Close up view of well stratified shale (GPS co-ordinates S 27° 49′ 56.1″ E 31° 47′ 49.3″)

Figure 23: Stratigraphy revealing siltstone on top of shale (GPS co-ordinates S 27° 48′ 33.8″ E 31° 46′ 32.2″)

Figure 24: Upper grindstone found next to a small dump of sand, gravel, stones and some litter indicating that it may have been moved from its original location (GPS co-ordinates S 27° 48′ 35.4″ E 31° 46′ 35.0″)

Figure 25: Core found close to river at GPS point S 27° 48′ 33.3″ E 31° 46′ 31.4″

Figure 26: At riverbed where pipeline crosses over heading west. Alluvial deposits very often harbour palaeontological and archaeological material so vigilance should be exercised when digging the trench along this section (GPS co-ordinates S 27° 48′ 25.95″ E 31° 46′ 20.06″)

Figure 27: Reservoir on top of hill which will be improved and upgraded as part of the pipeline project (GPS co-ordinates 27° 51′ 34.93″ E 31° 47′ 15.43″)

Figure 28: Stratigraphy on roadside containing siltstone, shale and mudstone (GPS co-ordinates S 27° 51′ 57.9″ E 31° 47′ 19.3″)

Figure 29: Close-up view of siltstone sitting on mudstone (GPS co-ordinates S 27° 51′ 57.9″ E 31° 47′ 19.3″)

Figure 30: Graves alongside the road (GPS co-ordinates S 27° 52′ 18.0″ E 31° 48′ 18.7″)

Figure 31: Small dams which will be improved and upgraded as part of the proposed project (GPS co-ordinates S 27° 53′ 22.1″ E 31° 51′ 39.3″)

Figure 32: Stratigraphy exposed along the side of the road indicating dolerite in the foreground and shale sitting on top of siltstone in the background (GPS co-ordinates S 27° 53′ 15.0″ E 31° 50′ 21.2″)

Figure 33: Stratigraphy depicting close-up view of shale on siltstone S 27° 53′ 15.0″ E 31° 50′ 21.2″

Figure 34: Site of proposed reservoir on top of small hill (GPS co-ordinates S 27° 52′ 12.0″ E 31° 44′ 17.9″)

Figure 35: Graves on side of road at GPS location S 27° 51′ 19.5″ E 31° 44′ 32.8″. These graves are situated very close to the route of the pipeline (see kml file)

Figure 36: Small reservoir on hill which will be improved and upgraded during this project (GPS co-ordinates S 27° 51′ 13.9″ E 31° 42′ 16.0″)

Figure 37: Young stratigraphic unit on side of road with many archaeological artefacts in vicinity (GPS co-ordinates S 27° 50′ 57.9″ E 31° 42′ 28.5″)

Figure 38: Quaternary deposits containing Stone Age and Iron Age archaeology sitting on top of coarse sandstone (GPS co-ordinates S 27° 50′ 59.66″ E 31° 42′ 25.58″)

Figure 39: Stone flake is among the many archaeological artefacts found at this site (GPS co-ordinates S 27° 50′ 59.66″ E 31° 42′ 25.58″)

Figure 40: Large quartzite core found at this archaeological site (GPS co-ordinates S 27° 50′ 59.66″ E 31° 42′ 25.58″)

Figure 41: Several thick-walled Iron Age pottery fragments were also recorded at this site (GPS co-ordinates S 27° 50′ 59.66″ E 31° 42′ 25.58″)

Figure 42: Stratigraphy at roadside containing lenses of shale, iron-rich siltstone and calcrete (GPS co-ordinates S 27° 50′ 19.5″ E 31° 43′ 27.6″)

Figure 43: Close-up view of stratigraphy showing thick lenses of calcrete (GPS co-ordinates S 27° 50′ 19.5″ E 31° 43′ 27.6″)

Figure 44: Graves at roadside on the way to location of proposed reservoir site (GPS co-ordinates S 27° 53′ 33.1″ E 31° 47′ 06.6″)

Figure 45: Adjacent to the graveyard, several pieces of pottery were observed lying on the surface or were embedded in the sand road (GPS co-ordinates S 27° 53′ 32.33″ E 31° 47′ 08.65″)

Figure 46: Examples of some of the pieces of thick-walled pottery lying on the surface adjacent to the graveyard (GPS co-ordinates S 27° 53′ 32.33″ E 31° 47′ 08.65″)

Figure 47: View of the site where the proposed reservoir will be built (GPS co-ordinates S 27° 53′ 39.85″ E 31° 47′ 17.17″)

Figure 48: Site on hill where proposed reservoir will be built (GPS co-ordinates S 27° 55′ 57.29″ E 31° 51′ 10.05″)

Figure 49: Looking west, site on top of hill where proposed reservoir will be built (GPS co-ordinates S 27° 56′ 08.88″ E 31° 53′ 06.24″)

Figure 50: Stratigraphy along roadside revealing thin lenses of mudstone and sandstone, sediments representing a fluvial system (GPS S 27° 56′ 56.86″ E 31° 50′ 21.21″)

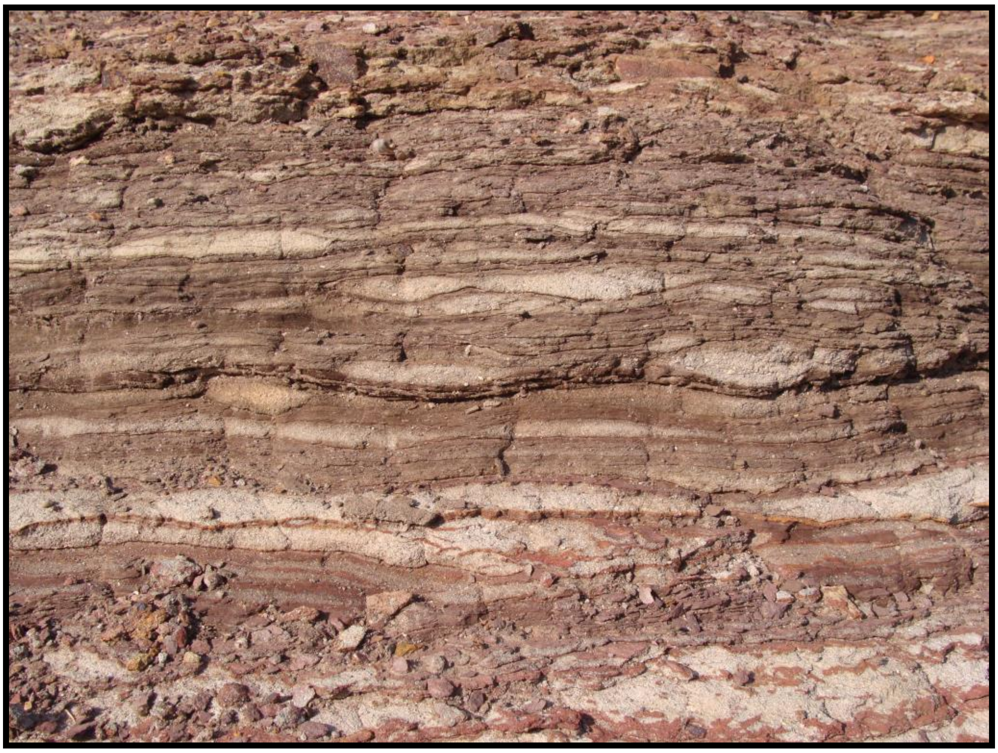

Figure 51: Close-up view of stratigraphy showing fine lenses of reddish mudstone and sandstone. These deposits are very likely to contain fossil material as their fluvial nature facilitates burial of material, creating conditions for possible preservation and fossilization (GPS S 27° 56′ 56.86″ E 31° 50′ 21.21″)

Figure 52: Site of existing reservoir which will be upgraded and improved as a result of this project (GPS co-ordinates S 27° 56′ 26.99″ E 31° 49′ 38.08″)

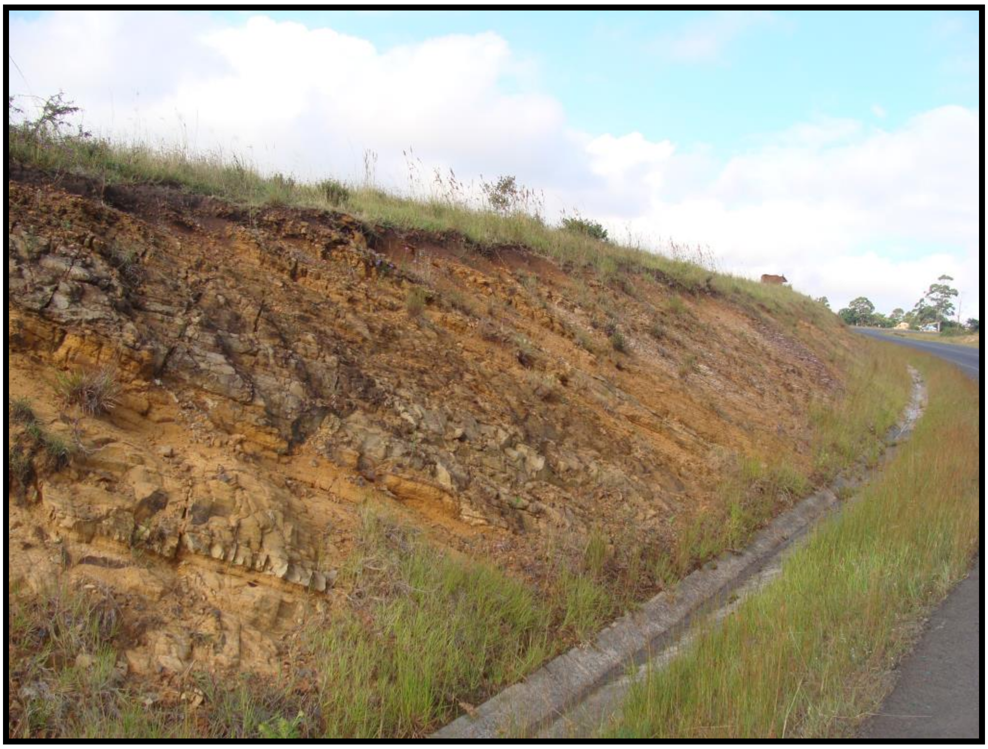

Figure 53: Stratigraphy on roadside showing well stratified mudstones and thick sandstone units (GPS co-ordinates S 27° 56′ 34.11″ E 31° 49′ 32.22″)

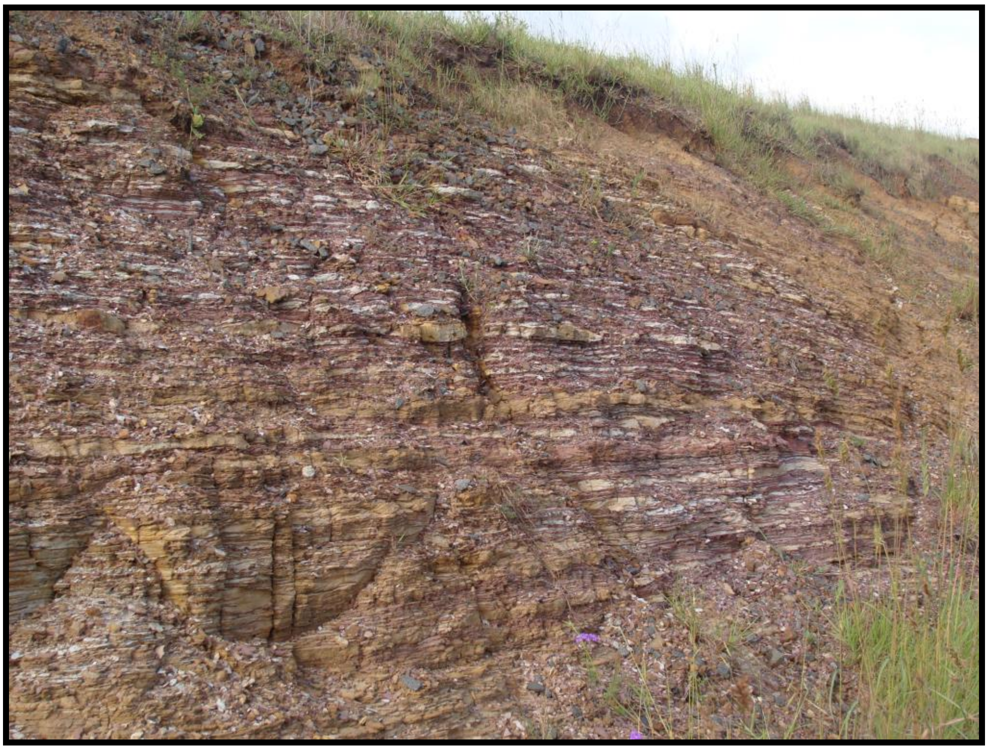

Figure 54: Close-up view of stratigraphy showing finely layered red mudstones and sandstones (GPS co-ordinates S 27° 56′ 34.11″ E 31° 49′ 32.22″)

Figure 55: Existing dams that will be upgraded and improved as a result of this project (GPS co-ordinates S 27° 57′ 14.95″ E 31° 46′ 22.83″)


Figure 56: Existing dams that will be upgraded as part of the goals of this project (GPS co-ordinates S 27° 57′ 14.95″ E 31° 46′ 22.83″)

Figure 57: Site of existing reservoir which will be upgraded and improved through this project (GPS co-ordinates S 27° 44′ 34.74″ E 31° 43′ 22.85″)

Figure 58: A pipe eroding out of the ground along the route of the pipeline as it leads up to one of the sites of the proposed reservoirs. This indicates that the underlying geology has already been disturbed during the construction of these features (GPS co-ordinates S 27° 44′ 20.1″ E 31° 43′ 54.4″)