

**HIA STUDY OF THE PROPOSED CONSTRUCTION OF
OFF TAKE 13A POTABLE WATER PIPELINE AS PART
OF THE LOWER THUKELA BULK WATER SUPPLY AT
SHAKA'S HEAD, ILEMBE DISTRICT MUNICIPALITY,
KZN**

FOR TRIPLO4 SUSTAINABLE SOLUTIONS

DATE: 3 FEBRUARY 2015

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INTRODUCTION

“The proposed construction for Off-take 13A forms part of the Lower Thukela Bulk Water Supply Scheme which is a project of the iLembe District Municipality and co-funded by the Department of Water Affairs. The construction of Off-take 13A is part of the sections of the potable water pipeline that forms part of the broader Bulk Water Supply Scheme in the lower Thukela Region.

The proposed construction of Off-take 13A potable water pipeline is part of the sections which form part of the water supply to Tongaat Industrial Development.

The proposed pipeline is located in Shaka’s Head off the N2 and is approximately 6.3 km in length with an outside diameter of approximately 800 mm. The proposed Off take 13A bulk water pipeline project makes provision for Bulk Supply of Potable water to communities that currently do not have access to reticulated potable water in the Lower Thukela Region” (Triplo4 BID 2014)

The study site is situated approximately 40 km to the north of Durban and 5km to the north of Ballito and Compensation at Shaka’s Head. Figures 1 – 3 show the location of the pipeline.

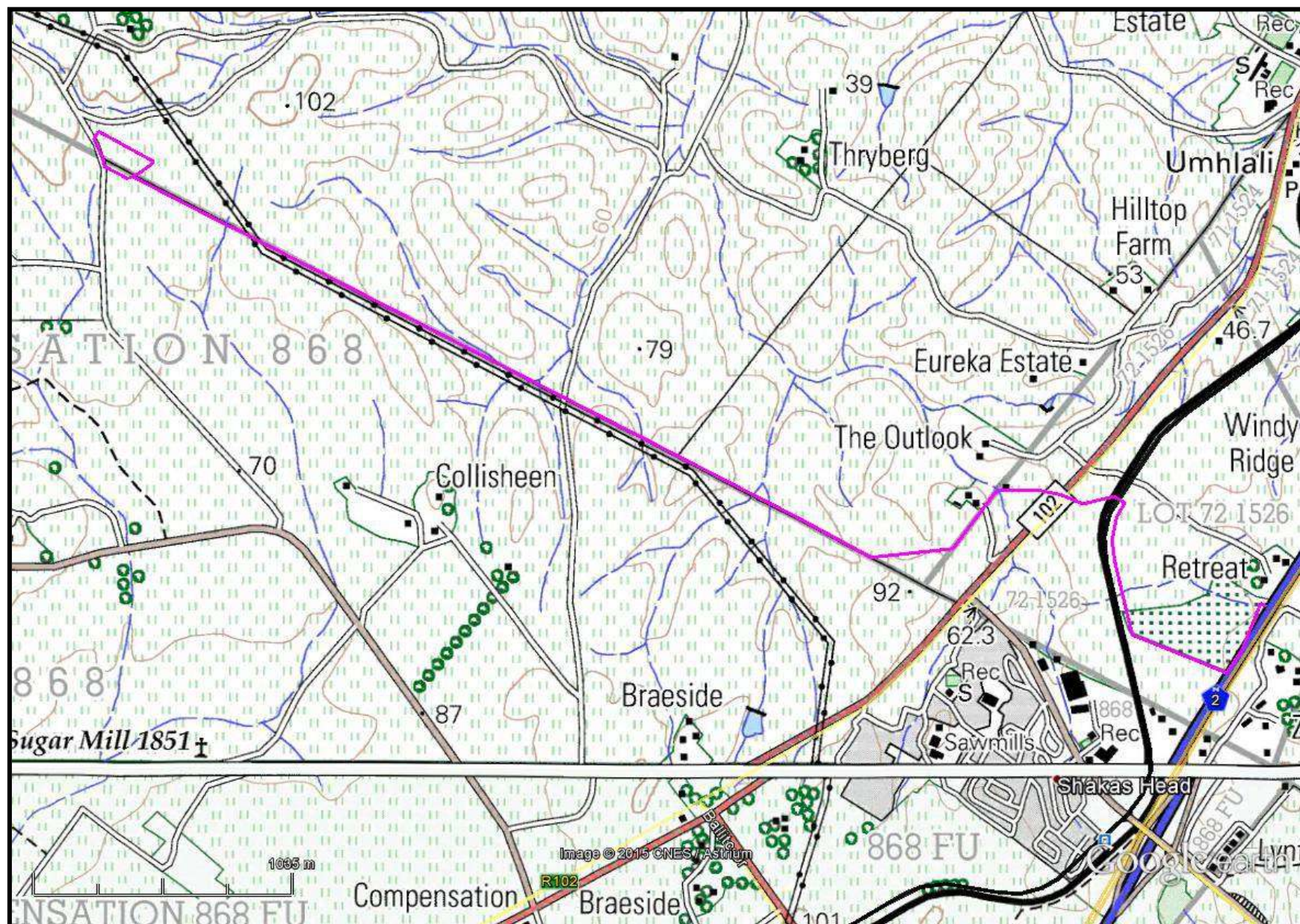
FIG. 1 GENERAL LOCATION OF THE STUDY AREA



FIG. 2: AERIAL OVERVIEW OF THE STUDY AREA



FIG. 3: TOPOGRAPHICAL MAP OF THE STUDY AREA



KWAZULU-NATAL HERITAGE ACT NO. 4 OF 2008

“General protection: Structures.—

- No structure which is, or which may reasonably be expected to be older than 60 years, may be demolished, altered or added to without the prior written approval of the Council having been obtained on written application to the Council.
- Where the Council does not grant approval, the Council must consider special protection in terms of sections 38, 39, 40, 41 and 43 of Chapter 9.
- The Council may, by notice in the *Gazette*, exempt—
 - A defined geographical area; or
 - defined categories of sites within a defined geographical area, from the provisions of subsection where the Council is satisfied that heritage resources falling in the defined geographical area or category have been identified and are adequately protected in terms of sections 38, 39, 40, 41 and 43 of Chapter 9.
- A notice referred to in subsection (2) may, by notice in the *Gazette*, be amended or withdrawn by the Council.

General protection: Graves of victims of conflict.—No person may damage, alter, exhume, or remove from its original position—

- the grave of a victim of conflict;
- a cemetery made up of such graves; or
- any part of a cemetery containing such graves, without the prior written approval of the Council having been obtained on written application to the Council.
- General protection: Traditional burial places.—
 - No grave—
 - not otherwise protected by this Act; and
 - not located in a formal cemetery managed or administered by a local authority, may be damaged, altered, exhumed, removed from its original position, or otherwise disturbed without the prior written approval of the Council having been obtained on written application to the Council.

The Council may only issue written approval once the Council is satisfied that—

- the applicant has made a concerted effort to consult with communities and individuals who by tradition may have an interest in the grave; and
- the applicant and the relevant communities or individuals have reached agreement regarding the grave.

General protection: Battlefield sites, archaeological sites, rock art sites, palaeontological sites, historic fortifications, meteorite or meteorite impact sites.—

- No person may destroy, damage, excavate, alter, write or draw upon, or otherwise disturb any battlefield site, archaeological site, rock art site, palaeontological site, historic fortification, meteorite or meteorite impact site without the prior written approval of the Council having been obtained on written application to the Council.
- Upon discovery of archaeological or palaeontological material or a meteorite by any person, all activity or operations in the general vicinity of such material or meteorite must cease forthwith and a person who made the discovery must submit a written report to the Council without delay.
- The Council may, after consultation with an owner or controlling authority, by way of written notice served on the owner or controlling authority, prohibit any activity considered by the Council to be inappropriate within 50 metres of a rock art site.
- No person may exhume, remove from its original position or otherwise disturb, damage, destroy, own or collect any object or material associated with any battlefield site, archaeological site, rock art site, palaeontological site, historic fortification, meteorite or meteorite impact site without the prior written approval of the Council having been obtained on written application to the Council.
- No person may bring any equipment which assists in the detection of metals and archaeological and palaeontological objects and material, or excavation equipment onto any battlefield site, archaeological site, rock art site, palaeontological site, historic fortification, or meteorite impact site, or

use similar detection or excavation equipment for the recovery of meteorites, without the prior written approval of the Council having been obtained on written application to the Council.

- The ownership of any object or material associated with any battlefield site, archaeological site, rock art site, palaeontological site, historic fortification, meteorite or meteorite impact site, on discovery, vest in the Provincial Government and the Council is regarded as the custodian on behalf of the Provincial Government.” (KZN Heritage Act of 2008)

METHOD

The method for Heritage assessment consists of several steps.

The first step forms part of the desktop assessment. Here we would consult the database that has been collated by Umlando. These databases contains archaeological site locations and basic information from several provinces (information from Umlando surveys and some colleagues), most of the national and provincial monuments and battlefields in Southern Africa (<http://www.vuvuzela.com/googleearth/monuments.html>) and cemeteries in southern Africa (information supplied by the Genealogical Society of Southern Africa). We use 1st and 2nd edition 1:50 000 topographical and 1937 aerial photographs where available, to assist in general location and dating of buildings and/or graves. The database is in Google Earth format and thus used as a quick reference when undertaking desktop studies. Where required we would consult with a local data recording centre, however these tend to be fragmented between different institutions and areas and thus difficult to access at times. We also consult with an historical architect, palaeontologist, and an historian where necessary.

The survey results will define the significance of each recorded site, as well as a management plan.

All sites are grouped according to low, medium, and high significance for the purpose of this report. Sites of low significance have no diagnostic artefacts or features. Sites of medium significance have diagnostic artefacts or features and these sites tend to be sampled. Sampling includes the collection of artefacts for future analysis. All diagnostic pottery, such as rims, lips, and decorated sherds are sampled, while bone, stone, and shell are mostly noted. Sampling usually occurs on most sites. Sites of high significance are excavated and/or extensively sampled. Those sites that are extensively sampled have high research potential, yet poor preservation of features.

Defining significance

Heritage sites vary according to significance and several different criteria relate to each type of site. However, there are several criteria that allow for a general significance rating of archaeological sites.

These criteria are:

1. State of preservation of:

- 1.1. Organic remains:
 - 1.1.1. Faunal
 - 1.1.2. Botanical
- 1.2. Rock art
- 1.3. Walling
- 1.4. Presence of a cultural deposit
- 1.5. Features:
 - 1.5.1. Ash Features
 - 1.5.2. Graves
 - 1.5.3. Middens
 - 1.5.4. Cattle byres
 - 1.5.5. Bedding and ash complexes

2. Spatial arrangements:

- 2.1. Internal housing arrangements
- 2.2. Intra-site settlement patterns
- 2.3. Inter-site settlement patterns

3. Features of the site:

- 3.1. Are there any unusual, unique or rare artefacts or images at the site?
- 3.2. Is it a type site?
- 3.3. Does the site have a very good example of a specific time period, feature, or artefact?

4. Research:

- 4.1. Providing information on current research projects
- 4.2. Salvaging information for potential future research projects

5. Inter- and intra-site variability

- 5.1. Can this particular site yield information regarding intra-site variability, i.e. spatial relationships between various features and artefacts?
- 5.2. Can this particular site yield information about a community's social relationships within itself, or between other communities?

6. Archaeological Experience:

- 6.1. The personal experience and expertise of the CRM practitioner should not be ignored. Experience can indicate sites that have potentially significant aspects, but need to be tested prior to any conclusions.

7. Educational:

- 7.1. Does the site have the potential to be used as an educational instrument?
- 7.2. Does the site have the potential to become a tourist attraction?
- 7.3. The educational value of a site can only be fully determined after initial test-pit excavations and/or full excavations.

8. Other Heritage Significance:

- 8.1. Palaeontological sites
- 8.2. Historical buildings

- 8.3. Battlefields and general Anglo-Zulu and Anglo-Boer sites
- 8.4. Graves and/or community cemeteries
- 8.5. Living Heritage Sites
- 8.6. Cultural Landscapes, that includes old trees, hills, mountains, rivers, etc related to cultural or historical experiences.

The more a site can fulfill the above criteria, the more significant it becomes. Test-pit excavations are used to test the full potential of an archaeological deposit. This occurs in Phase 2. These test-pit excavations may require further excavations if the site is of significance (Phase 3). Sites may also be mapped and/or have artefacts sampled as a form of mitigation. Sampling normally occurs when the artefacts may be good examples of their type, but are not in a primary archaeological context. Mapping records the spatial relationship between features and artefacts.

RESULTS

DESKTOP STUDY

The desktop study consisted of analysing various maps for evidence of prior habitation in the study area, as well as for previous archaeological surveys. The archaeological database indicates that there are archaeological sites in the general area (fig. 4). These sites include all types of Stone Age and Iron Age sites. No sites occur in the study area. I would expect a Late Iron Age site to occur on the hill at the location of the reservoir. No national monuments, battlefields, or historical cemeteries are known to occur in the study area. There are several cemeteries outside of the study area, as well as the first sugar mill in KZN (1851).

“In 1846, Mr. Edmond Morewood was granted a large farm near Umhlali, which he called "Compensation", and where he practiced the first commercial sugar cane growing.

Morewood [had] been inspired by a visit to the islands off South Africa's East Coast, like Mauritius and Reunion, where he had been introduced to sugar cane growing and the sugar industry. He then had seed cane shipped back to Natal, which he planted. He also built a small mill there, using the masts of a sailing ship wrecked off Compensation Beach (now Ballito), which he cut into lengths to form rollers to squeeze out the juice from the cane. In January 1851, he proudly took his first processed sugar to the Durban market for sale, and is thus acclaimed as the pioneer of the Natal sugar industry” (<http://www.sahistory.org.za/places/kwadukuza-timeline>). The Sugar Mill is ~950m southwest of the western pipeline.

The 1937 aerial photographs indicate that there are four areas that have heritage sites (fig. 6). Two of these are settlements, one is the Farmhouse Retreat, and the fourth is a railway. Railways older than 60 years are protected by the heritage legislation. The 1968 topographical map indicates that there are two buildings: one is the original farmhouse Retreat and the other is a compound (fig. 7).

The recent aerial imagery (fig. 2) indicates that Retreat is now a ruin. The settlements have been covered by sugar cane farming. The railway line is still in use. Only the railway line and the ‘compound’ will be affected by the pipeline.

Table 1 lists the locations of the sites.

FIG. 4: LOCATION OF KNOWN HERITAGE SITES NEAR THE STUDY AREA

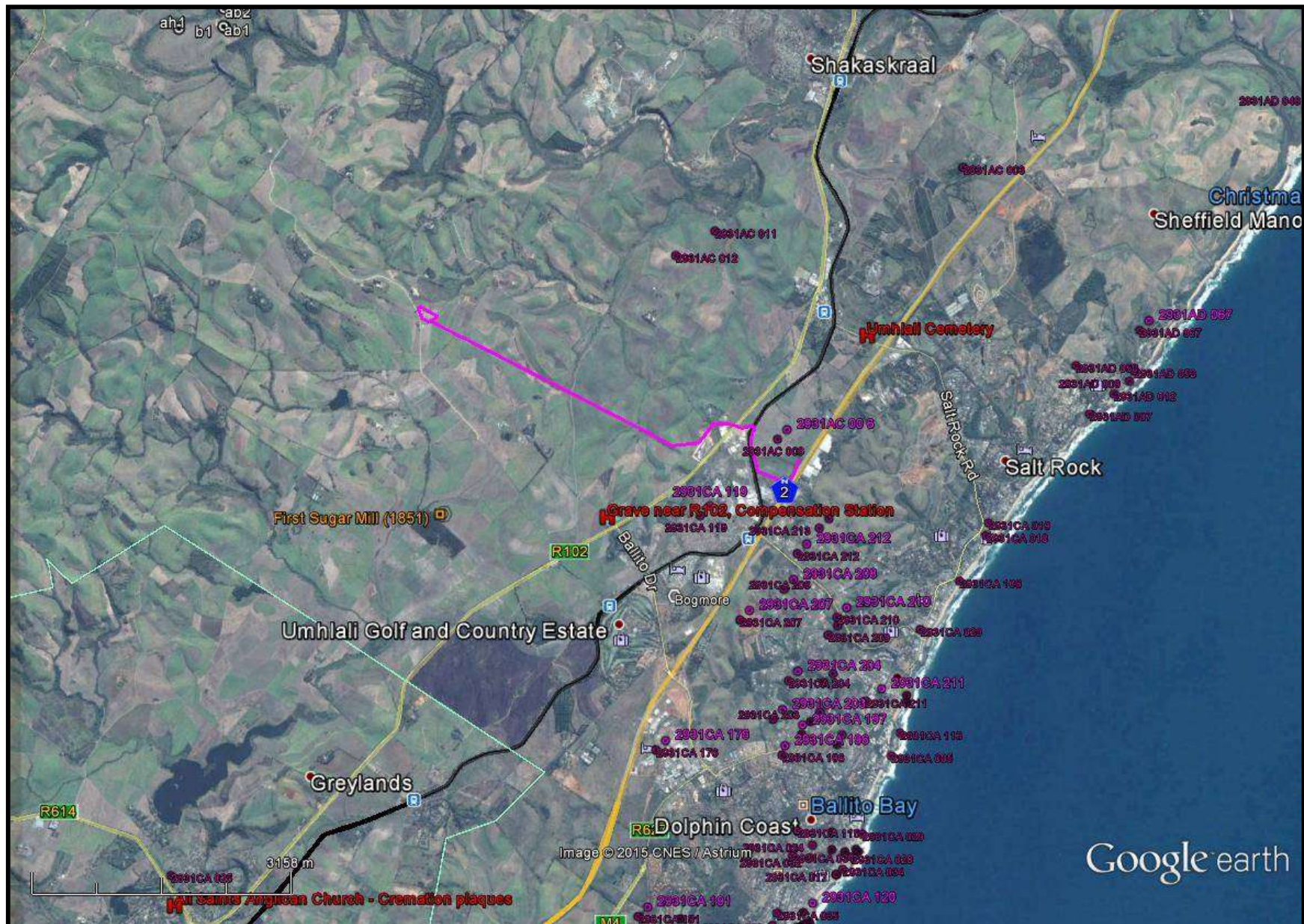


FIG. 5: SURVEYOR GENERAL DIAGRAM OF GRANT: 1849

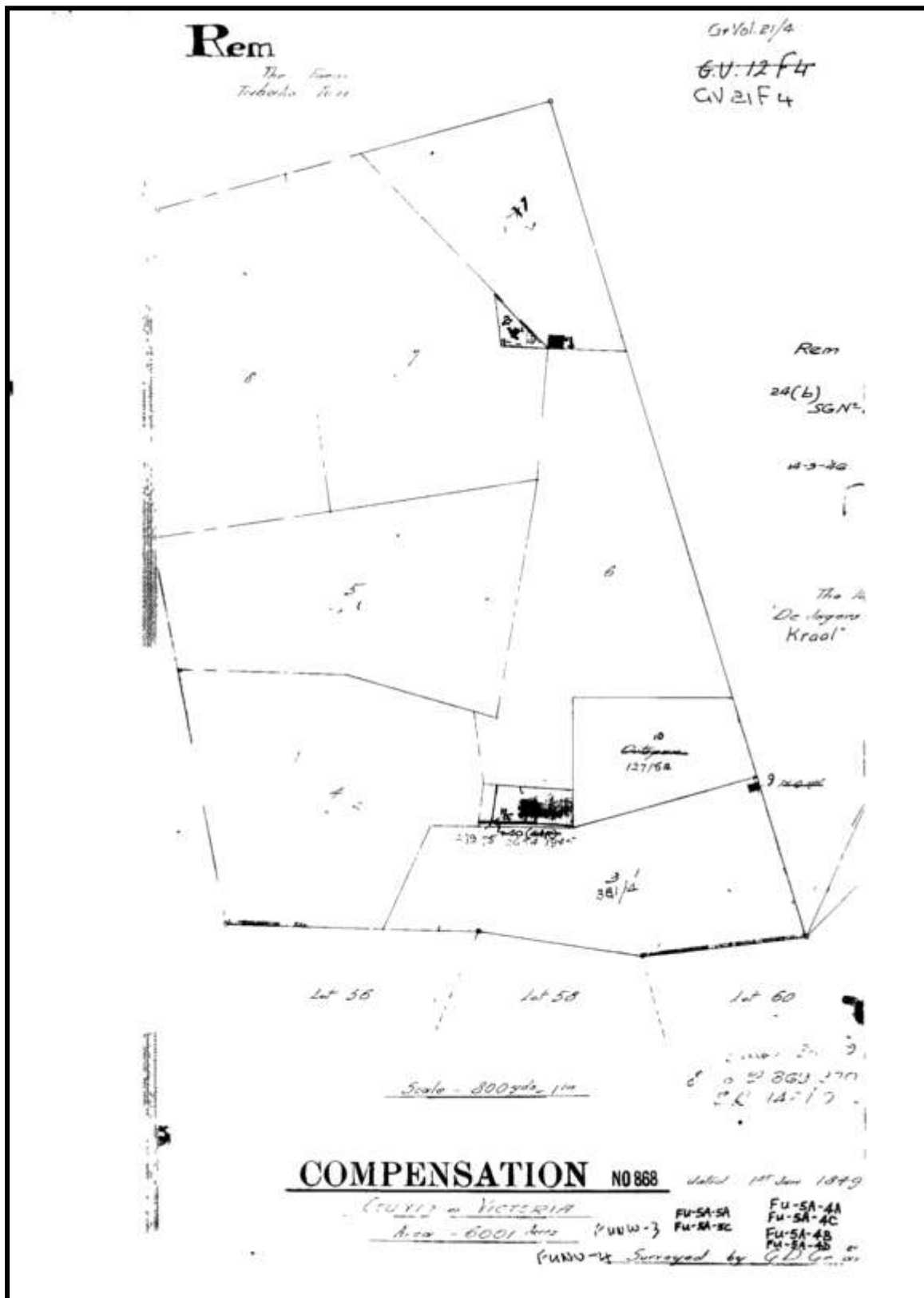


FIG. 6: STUDY AREA IN 1937



FIG. 7: STUDY AREA IN 1968

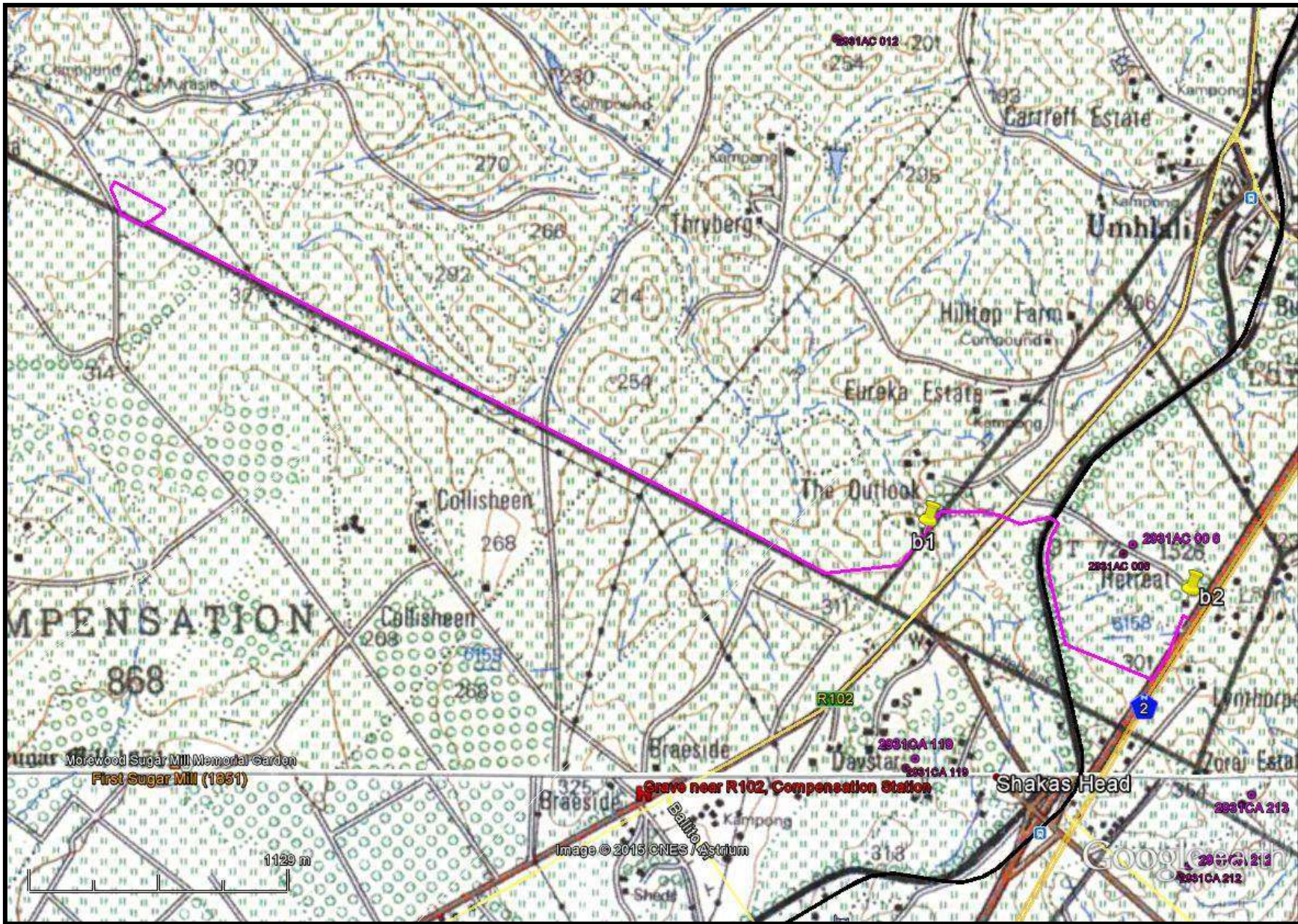


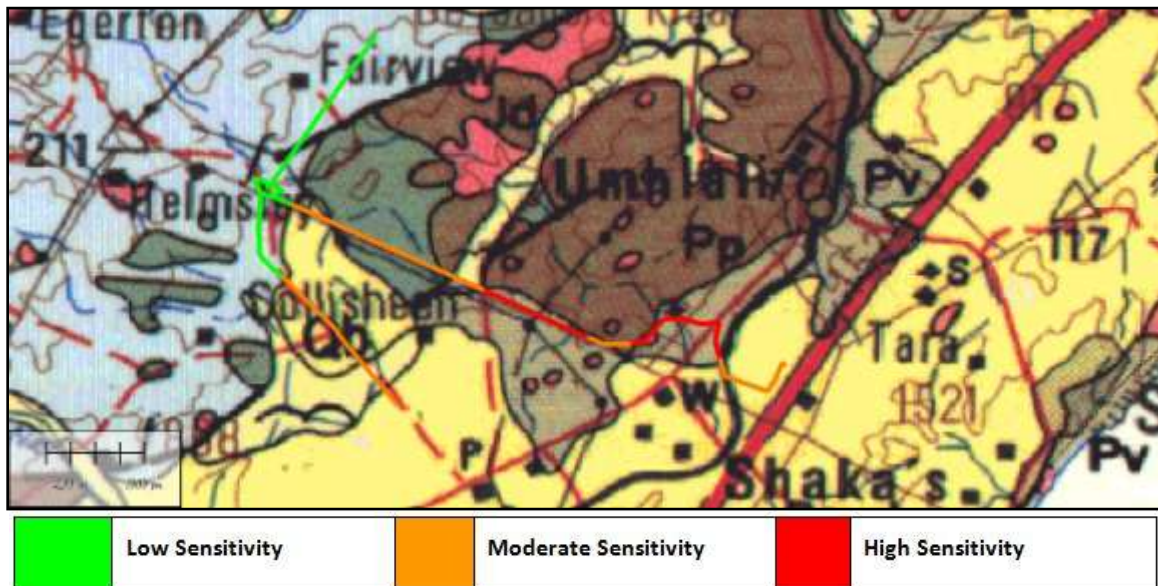
TABLE 1: LOCATION OF HERITAGE SITES FROM HISTORICAL MAPS

NAME	LATITUDE	LONGITUDE	DESC
a1	-29.482606836	31.173357070	settlement/feature
a2	-29.490451904	31.209259764	historical railway
a3	-29.491500452	31.210167016	feature
a4	-29.493491103	31.215720019	buildings
b1	-29.490926032	31.203588822	buildings
b2	-29.493586413	31.215260698	Retreat

PALAEONTOLOGICAL IMPACT ASSESSMENT

THE PIA desktop notes that the line fall in some sensitive geological formations. Low Palaeontological sensitivity for sections underlain by the Natal Group. Moderate Palaeontological sensitivity for areas underlain by Dwyka, Pietermaritzburg and Berea Formations as well as the alluvium regions. High Palaeontological sensitivity for areas underlain by the Vryheid Formation. Fig. 8 indicates where these area occur on the line.

In all areas where the Vryheid Formation is exposed or likely to be exposed during excavation, a professional palaeontologist must be appointed to record and collect fossils from the formation as part of a Phase 1 Palaeontological Impact Assessment. For all other areas the ECO must, report the presence of fossils to the professional palaeontologist for appropriate action. It would be the client to determine where these depths occur.

FIG. 8: PALAEOONTOLOGICAL SENSITIVITY FOR OFFTAKE 13A

FIELD SURVEY

The field survey followed the pipeline route. The route passes through several hills that are under sugar cane cultivation. The soils vary in depth, and are mostly on a black soil. These types of soils tend not to yield archaeological sites in my experience. Fig. 9 shows the various views of the line.

The pipeline does not impact on any built structures. The railway has been fixed and replaced several times since the original railway. The route has also deviated in some areas. The pipeline will be pipe jacked underneath the railway and thus not impact on the railway itself.

FIG. 8: SCENIC VIEWS OF OFF TAKE 13 A



CONCLUSION

A desktop heritage survey was undertaken for the Off take 13A pipeline. Several heritage sites were noted to have occurred near the proposed pipeline footprint. These sites include built structures and human settlements. The pipeline footprint occurs in a few geological formations with moderate sensitivity. A qualified palaeontologist will need to be appointed to undertake the necessary mitigation in those sensitive area, especially where the excavations will be more than 2m in depth.

The field survey did not locate any heritage sites within the pipeline footprint and no further mitigation is required.

APPENDIX A
PIA DESKTOP REPORT

**DESKTOP PALAEOLOGICAL
ASSESSMENT FOR
THE PROPOSED OFFTAKE 13a, 13b AND
13c, KWADUKUZA LOCAL MUNICIPALITY,
ILEMBE DISTRICT
MUNICIPALITY, KWAZULU-NATAL
PROVINCE.**

**FOR
Umlando**

DATE: 30 January 2015

By

**Gideon Groenewald
Cell: 082 339 9202**

EXECUTIVE SUMMARY

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of the Offtake 13a, 13b and 13c projects near Umhlali, KwaDukuza Local Municipality, Ilembe District Municipality, Kwazulu-Natal Province.

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999 as well as the KwaZulu-Natal Heritage Act No 4 of 2008. In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

The footprint of the proposed construction of Offtake 13a-c project near Umhlali, Kwadukuza Local Municipality, Ilembe District Municipality, Kwazulu-Natal Province is underlain by Ordovician to Silurian aged quartzite of the Natal Group, Carboniferous to Permian aged tillite of the Dwyka Formation, Permian aged shale of the Pietermaritzburg Formation, Permian aged sandstone and shale of the Vryheid Formation, Quaternary aged sand dunes of the Berea Formation and Quaternary aged alluvium. No significant fossils have to date, been described from the Natal Group quartzites, shales of the Pietermaritzburg Formation or the alluvial deposits from this part of KwaZulu-Natal. Although rare, significant fossils have however been described from the Dwyka Formation, with specific reference to trace fossils. Significant plant fossils are present in the Vryheid Formation. Recording of fossils from the construction site will contribute significantly to our understanding of the palaeo-environments that existed during deposition of the formations underlying the development footprint the following allocations of Palaeontological sensitivity were made:

Offtake 13a: Low Palaeontological sensitivity for sections underlain by the Natal Group. Moderate Palaeontological sensitivity for areas underlain by Dwyka, Pietermaritzburg and Berea Formations as well as the alluvium regions. High Palaeontological sensitivity for areas underlain by the Vryheid Formation.

Offtake 13b: Low Palaeontological sensitivity for the areas underlain by the Natal Group and Moderate Palaeontological sensitivity for areas underlain by Berea Formation and alluvium.

Offtake 13c: Low Palaeontological sensitivity for the entire section as it is underlain by Natal Group quartzites.

Although it can be assumed that most of the study area is covered by soil or weathered rock, it is expected that excavations of the trenches for the pipelines will be deeper than 1.5 m, and it is likely that fresh bedrock will be exposed. A Moderate Palaeontological Sensitivity is therefore allocated to all sections of the development site where fossils might be present and any observation of fossils must be reported to the ECO.

Recommendations:

1. The EAP and ECO of the project must be informed of the fact that the Vryheid Formation normally contains plant fossils and that trace fossils have been described from the Dwyka and Pietermaritzburg Formations that underlies part of the development site.
2. All sections of the development where bedrock is exposed due to erosion or where geotechnical surveys indicate that bedrock will be exposed during excavation, must be inspected by the ECO and if fossils are recorded, a professional Palaeontologist must be appointed to record and collect the fossils according to SAHRA and AMAFA specifications as part of a Phase 1 Palaeontological Impact Assessment.
3. .Specific recommendations for each offtake:
 - 3.1 Offtake 13a. In all areas where the Vryheid Formation is exposed or likely to be exposed during excavation, a professional palaeontologist must be appointed to record and collect fossils from the formation as part of a Phase 1 Palaeontological Impact Assessment. For all other areas the ECO must, report the presence of fossils to the professional palaeontologist for appropriate action.
 - 3.2 Offtake 13b. The ECO must inspect all excavations for the presence of fossils and if fossils are present, a professional palaeontologist must be appointed to record and collect the fossils according to SAHRA and AMAFA specifications.
 - 3.3 Offtake 13c. No fossils are expected along the route of this development and no further Palaeontological mitigation or assessment is recommended.

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INTRODUCTION

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential palaeontological impact of the proposed construction of the Offtake 13a, 13b and 13c projects near Umhlali, KwaDukuza Local Municipality, Ilembe District Municipality, Kwazulu-Natal Province (figure 1).



Figure 1. Localities of offtakes 13a (red), 13b (blue) and 13c (magenta) west of Umhlali

SOUTH AFRICAN NATIONAL HERITAGE RESOURCE ACT NO 25/1999 AND KWAZULU-NATAL HERITAGE ACT NO 4/2008

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999 as well as the KwaZulu-Natal Heritage Act No 4 of 2008. In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

METHODOLOGY

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

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess 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.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc) represented within the study area are determined from geological maps and Google Earth imagery. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

The likely impact of the proposed development on local fossil heritage is 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 1 below.

Table 1 Palaeontological sensitivity analysis outcome classification

Sensitivity	Description
Low Sensitivity	Areas where there is likely to be a negligible impact on the fossil heritage. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.
Moderate Sensitivity	Areas where fossil bearing rock units are present but fossil finds are localised or within thin or scattered sub-units. Pending the nature and scale of the proposed development the chances of finding fossils are moderate. A field-based assessment by a professional palaeontologist is usually warranted.
High Sensitivity	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops and the chances of finding fossils during a field-based assessment by a professional palaeontologist are very high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field-based assessment by a professional palaeontologist is usually warranted.

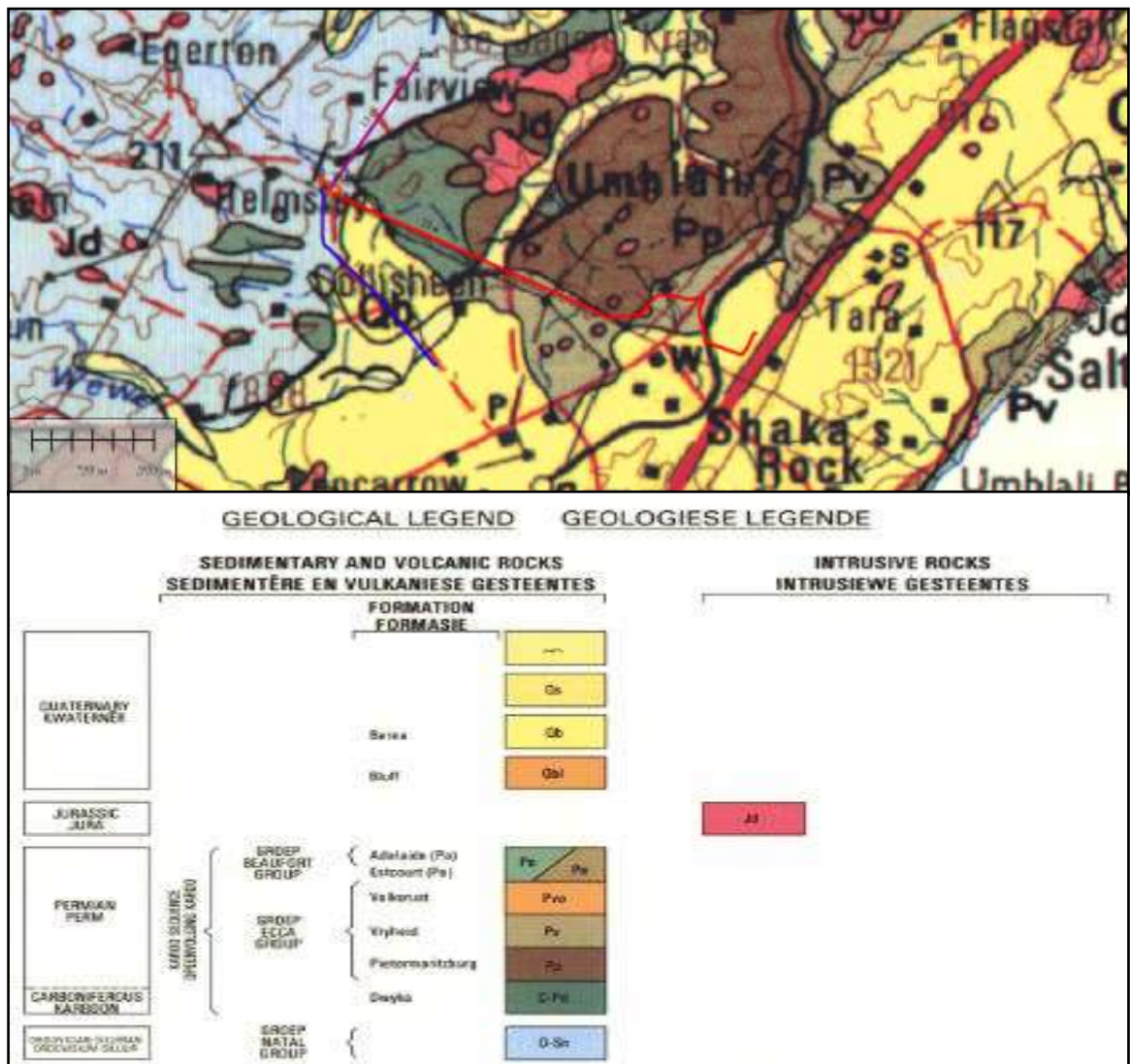
The key assumption for this desktop study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and, without supporting field assessments, may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium etc).

GEOLOGY

The study area is underlain by Ordovician to Silurian aged rocks of the Natal Group, Carboniferous to Permian aged rocks of the Dwyka Formation, Permian aged rocks of the Pietermaritzburg Formation, Eccca Group, of the Karoo Supergroup and Quaternary aged alluvium (Figure 2).



Dwyka Formation (C-Pd)

The Carboniferous to Permian aged Dwyka Formation consists mainly of poorly sorted tillites. The rocks overlying the Natal Group is a thick unit of tillite that was deposited in a glacial environment by retreating ice sheets about 300 million years ago.

At this time South Africa was part of the supercontinent Gondwana, which was situated near the South Pole and covered with ice. Rocks imbedded in the slowly moving ice sheets scoured and polished the underlying older rocks giving rise to glacial pavements. Striation directions indicate that ice flow was from north to south - valuable information when it comes to reconstructing Gondwana

Pietermaritzburg Formation (Pp)

The Permian aged Pietermaritzburg Formation is the lower most formation of the Ecca Group, which is part of the Karoo Supergroup. The Pietermaritzburg Formation is an assemblage of fine-grained sediments, consisting mainly of dark grey mudstone and shale. The deposits represent Permian aged marine deposits in this part of Gondwanaland (Johnson et al, 2006). Basinal dark mudrocks with phosphatic / carbonate / sideritic concretions can be present.

Offshore shelf, but possibly also nearshore / lacustrine / lagoonal deposits.

Vryheid Formation (Pv)

The Permian aged Vryheid Formation overlies the Pietermaritzburg shale and is a thick sequence of sandstone and shale, dominated by light grey sandstones. These sandstones were deposited along ancient sandy shorelines behind which lay vast swamplands. Burial of vegetation in the swamps eventually formed coal which is mined in KwaZulu-Natal (Johnson et al 2006).

Berea Formation (Qb)

The Berea Formation consists of red, orange and yellow Aeolian sand, present in the form of dune cordons along the coast of KwaZulu-Natal. The Berea

Formation is interpreted as the weathering product of the Bluff Formation (Wolmarans and Du Preez, 1986).

Alluvium

Quaternary aged alluvium consists mostly of sandy to mud-rich sandy deposits along the major river and stream systems.

PALAEONTOLOGY

Natal Group (O-Sn)

Up to date, no fossils have been recorded from the Natal Group sediments. Trace fossils are common in equivalent groups of rock in South Africa and the recording of fossils from these rock units will be significant.

Dwyka Formation (C-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 potentially be found in KwaZulu-Natal. 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 chondrichthyans (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 *Peruvipiraviperdorfensis*), bivalves (*Nuculopsis* sp., *Phestia* sp., *Aphanaiahaibensis*, *Eurydesmamytiloides*), brachiopods (*Attenuatella* sp.) and palaeoniscoid fish such as *Namaichthysschroederi* and *Watsonichthys lotzi*.

Fossil plants have also been found, including lycopods (*Leptophloema australe*), 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).

Pietermaritzburg Formation (Pp)

Fossils are generally absent from the Formation although trace fossils have been recorded from the upper layers of the Pietermaritzburg Formation by Linstrom (1987).

Vryheid Formation (Pv)

The Vryheid Formation is well-known for the occurrence of coal beds that resulted from the accumulation of plant material over long periods of time. Plant fossils described by Bamford (2011) from the Vryheid Formation are; *Azaniodendron fertile*, *Cyclodendron leslii*, *Sphenophyllum hammanskraalensis*, *Annularia* sp., *Raniganjia* sp., *Asterotheca* spp., *Liknometalon enigmata*, *Glossopteris* > 20 species, *Hirsutum* 4 spp., *Scutum* 4 spp., *Ottokaria* 3 spp., *Estcourtia* sp., *Arberia* 4 spp., *Lidgettonia* sp., *Noeggerathiopsis* sp. and *Podocarpidites* sp.

According to Bamford (2011) "Little data have been published on these potentially fossiliferous deposits. Around the coalmines there is most likely to be good material and yet in other areas the exposures may be too poor to be of interest. When they do occur fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites, however, in the interests of heritage and science such sites should be well recorded, sampled and the fossils kept in a suitable institution.

Although no vertebrate fossils have been recorded from the Vryheid Formation, invertebrate trace fossils have been described in some detail by Mason and Christie (1985). It should be noted, however, that the aquatic reptile, *Mesosaurus*, which is the earliest known reptile from the Karoo Basin, as well as fish (*Palaeoniscuscapensis*), have been recorded in equivalent-aged strata in the Whitehill Formation in the southern part of the basin (MacRae, 1999; Modesto, 2006). Indications are that the Whitehill Formation in the main basin might be correlated with the mid-Vryheid Formation. If this assumption proves correct, there is a possibility that *Mesosaurus* could be found in the Vryheid Formation (Catuneanu et al 2005).

The late Carboniferous to early Jurassic Karoo Supergroup of South Africa includes economically important coal deposits within the Vryheid Formation of

Natal. The Karoo sediments are almost entirely lacking in body fossils but ichnofossils (trace fossils) are locally abundant. Modern sedimentological and ichnofaunal studies suggest that the north-eastern part of the Karoo basin was marine. In KwaZulu-Natal a shallow basin margin accommodated a prograding fluviodeltaic complex forming a broad sandy platform on which coal-bearing sediments were deposited. Ichnofossils include U-burrows (formerly *Corophioides*) which are assigned to ichnogenus *Diplocraterion* (Mason and Christie, 1985).

Berea Formation (Qb)

No significant vertebrate fossils have been recorded from the Berea Formation (Wolmarans and Du Preez, 1986). Petrified wood with fossil wood, flattened *Syzigium* logs, have however been described from the Formation.

Alluvium

Up to date no significant fossils have been described from the alluvium deposits along the streams of this part of KwaZulu-Natal. Significant fossils have however been reported from similar deposits in other parts of South Africa and the recording of fossils from these sediments will be highly significant.

DISCUSSION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews. No fossils are expected in areas underlain by the Natal Group sediments. Although fossils are rarely recorded from the Dwyka and Pietermaritzburg Formations, the recording of trace fossils and other fossils from this part of the Ecca Basin will contribute significantly to our understanding of the palaeo-environments that existed during the Permian. The Vryheid Formation is known to contain well-preserved plant fossils. Plant fossils have been recorded from the Berea Formation and it is unlikely that the alluvial deposits will contain significant fossils.

MANAGEMENT PLAN

The likely impact of the proposed development on local fossil heritage is 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 1.

The palaeontological sensitivity of the development is related to the specific geology that underlies the development footprints. For the sake of this desktop survey it is assumed that there are no significant outcrops on site, but that trenching of up to 2m depth will in fact expose fresh bedrock of all the geological formations recorded in the desktop survey. Due to the fact that the recording of fossils will have a significant impact on our understanding of the palaeo-environments in this part of the basin, a ModeratePalaeontological sensitivity is allocated to all areas with a potential to have fossils at the study site.

The palaeontological sensitivity of the study area is shown in Figure 3.

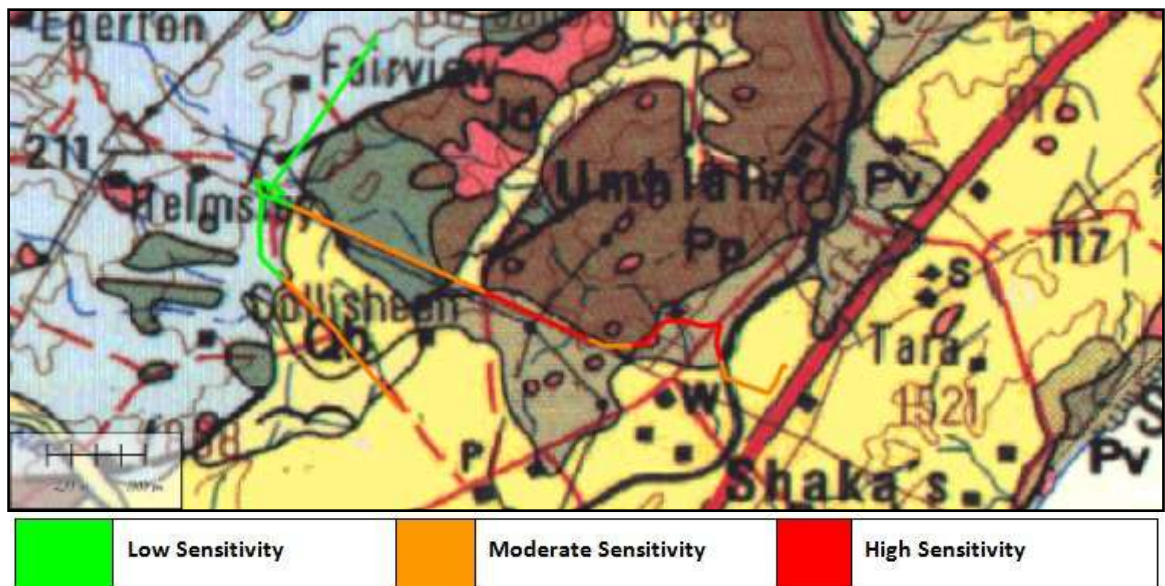


Figure 3 Palaeontological sensitivity for offtake 13a-c. Sensitivity classes discussed in Table 1

CONCLUSION AND RECOMMENDATIONS

The footprint of the proposed construction of Offtake 13a-c project near Umhlali, Kwadukuza Local Municipality, Ilembe District Municipality, KwaZulu-Natal Province is underlain by Ordovician to Silurian aged quartzite of the Natal Group, Carboniferous to Permian aged tillite of the Dwyka Formation, Permian aged shale of the Pietermaritzburg Formation, Permian aged sandstone and shale of the Vryheid Formation, Quaternary aged sand dunes of the Berea

Formation and Quaternary aged alluvium. No significant fossils have to date, been described from the Natal Group quartzites, shales of the Pietermaritzburg Formation or the alluvial deposits from this part of KwaZulu-Natal. Although rare, significant fossils have however been described from the Dwyka Formation, with specific reference to trace fossils. Significant plant fossils are present in the Vryheid Formation. Recording of fossils from the construction site will contribute significantly to our understanding of the palaeo-environments that existed during deposition of the formations underlying the development footprint the following allocations of Palaeontological sensitivity were made:

Offtake 13a: Low Palaeontological sensitivity for sections underlain by the Natal Group. Moderate Palaeontological sensitivity for areas underlain by Dwyka, Pietermaritzburg and Berea Formations as well as the alluvium regions. High Palaeontological sensitivity for areas underlain by the Vryheid Formation.

Offtake 13b: Low Palaeontological sensitivity for the areas underlain by the Natal Group and Moderate Palaeontological sensitivity for areas underlain by Berea Formation and alluvium.

Offtake 13c: Low Palaeontological sensitivity for the entire section as it is underlain by Natal Group quartzites.

Although it can be assumed that most of the study area is covered by soil or weathered rock, it is expected that excavations of the trenches for the pipelines will be deeper than 1.5 m, and it is likely that fresh bedrock will be exposed. A Moderate Palaeontological Sensitivity is therefore allocated to all sections of the development site where fossils might be present and any observation of fossils must be reported to the ECO.

Recommendations:

1. The EAP and ECO of the project must be informed of the fact that the Vryheid Formation normally contains plant fossils and that trace fossils have been described from the Dwyka and Pietermaritzburg Formations that underlies part of the development site.
2. All sections of the development where bedrock is exposed due to erosion or where geotechnical surveys indicate that bedrock will be exposed during excavation, must be inspected by the ECO and if fossils are recorded, a professional Palaeontologist must be appointed to record and collect the fossils according to SAHRA and AMAFA specifications as part of a Phase 1 Palaeontological Impact Assessment.

3. Specific recommendations for each offtake:

3.1 Offtake 13a. In all areas where the Vryheid Formation is exposed or likely to be exposed during excavation, a professional palaeontologist must be appointed to record and collect fossils from the formation as part of a Phase 1 Palaeontological Impact Assessment. For all other areas the ECO must, report the presence of fossils to the professional palaeontologist for appropriate action.

3.2 Offtake 13b. The ECO must inspect all excavations for the presence of fossils and if fossils are present, a professional palaeontologist must be appointed to record and collect the fossils according to SAHRA and AMAFA specifications.

3.3 Offtake 13c. No fossils are expected along the route of this development and no further Palaeontological mitigation or assessment is recommended.

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeo-ecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

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.



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