

**SURVEY OF THE PROPOSED BHEKUZULU,  
EPANGWENI AND ENNERSDALE WATER SUPPLY  
SCHEME, ESTCOURT, KWAZULU-NATAL**

**FOR TERRATEST (PTY) LTD**

**DATE: 8 APRIL 2016**

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## TABLE OF CONTENT

INTRODUCTION .....	3
<b>KWAZULU-NATAL HERITAGE ACT NO. 4 OF 2008 .....</b>	<b>10</b>
METHOD .....	12
Defining significance.....	13
RESULTS .....	15
DESKTOP STUDY .....	15
FIELD SURVEY.....	16
PALAEONTOLOGICAL IMPACT ASSESSMENT .....	23
CONCLUSION.....	25
APPENDIX A .....	26
PALAEONTOLOGICAL IMPACT DESKTOP STUDY .....	26

## TABLE OF FIGURES

FIG. 1 GENERAL LOCATION OF THE STUDY AREA.....	4
FIG. 2: AERIAL OVERVIEW OF THE STUDY AREA .....	5
FIG. 3: TOPOGRAPHICAL OVERVIEW OF THE STUDY AREA.....	6
FIG. 4: SCENIC VIEWS OF THE PIPELINE ROUTE .....	7
FIG. 5: VIES OF VARIOUS OFFTAKES .....	8
FIG. 6: VIES OF VARIOUS OFFTAKES .....	9
FIG. 7: LOCATION OF KNOWN HERITAGE SITES NEAR THE STUDY AREA.....	17
FIGURE 8: SURVEYOR GENERAL FARM BOSCHOEK (1852) .....	18
FIGURE 9: SURVEYOR GENERAL FARM DRAYCOT (1902) .....	19
FIGURE 10: SURVEYOR GENERAL FARM BERGVLIET 857(1862) .....	20
FIG. 11: STUDY AREA IN 1942, and 1945.....	21
FIG. 12: REMAINS OF FARM BERGVLIET 857.....	22
FIG. 13: PALAEONTOLOGICAL SENSITIVITY OF THE BWSS.....	24

## **INTRODUCTION**

Umlando was appointed by uThukela District Municipality to undertake a heritage survey of the Bhekuzulu, Epangweni and Ennersdale water supply scheme. The project occurs 15km – 20km west of Estcourt, on either side of the P10-1.

The pipeline will update and/or provide new water reticulation for the area of Bhekuzulu and Empangweni. Most of the pipeline follows existing roads and will occur just outside of the road reserve. The surfaces of some of these areas have been disturbed by roadworks and previous water reticulation systems.

The pipeline will involve:

- Trenches with a depth of 1.1m – 1.5m.
- The pipes vary from 50mm dia. up to 200mm dia.
- The working footprint of 2m in width
- ~112km of reticulation pipeline
- ~8.3km of bulk pipeline

Figures 1 – 3 show the location of the project. Figure 4 shows the general view of the main Bhekuzulu area. Figure 5 - 6 show the various views of various offtakes related to the pipeline.

FIG. 1 GENERAL LOCATION OF THE STUDY AREA

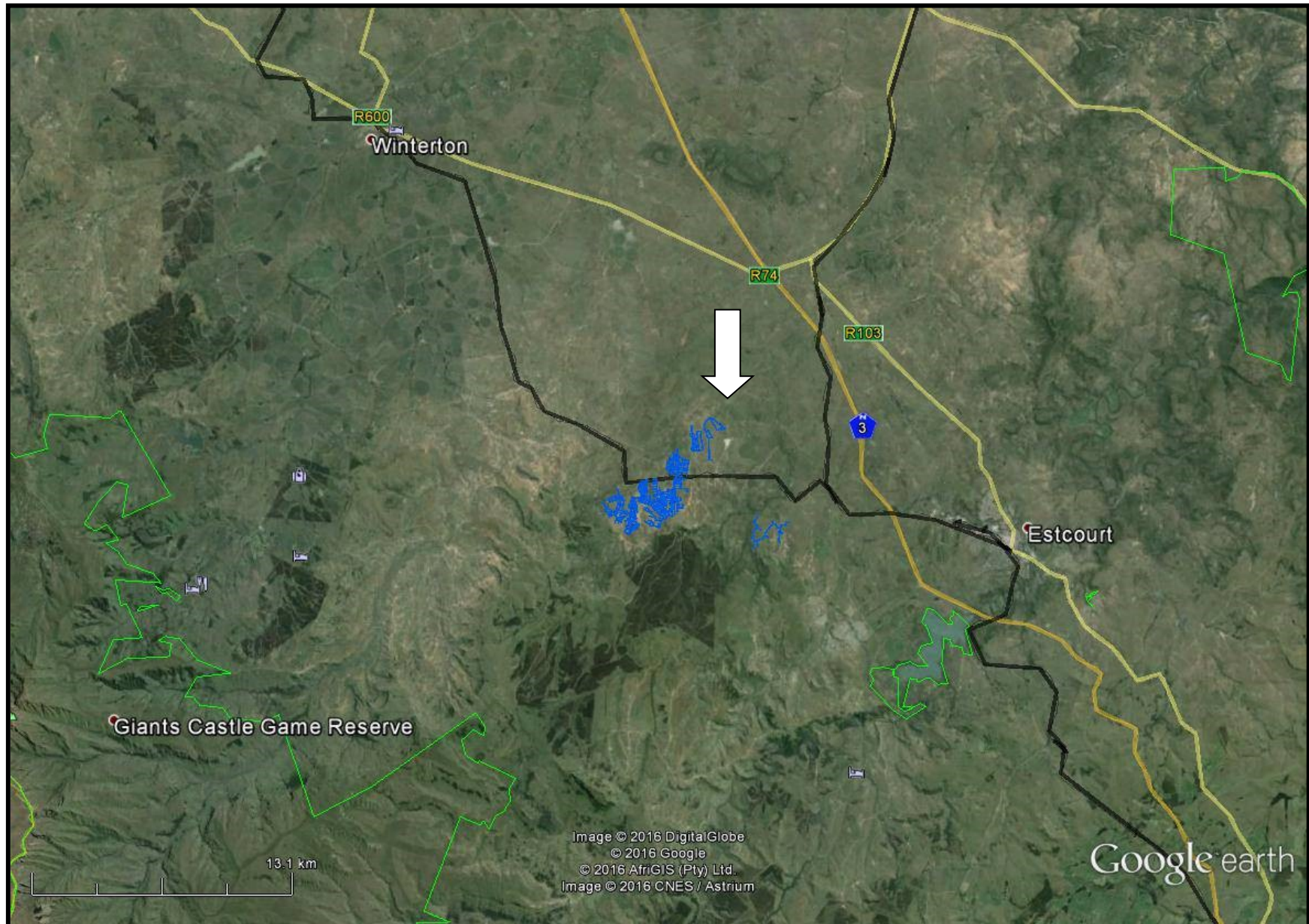




FIG. 2: AERIAL OVERVIEW OF THE STUDY AREA

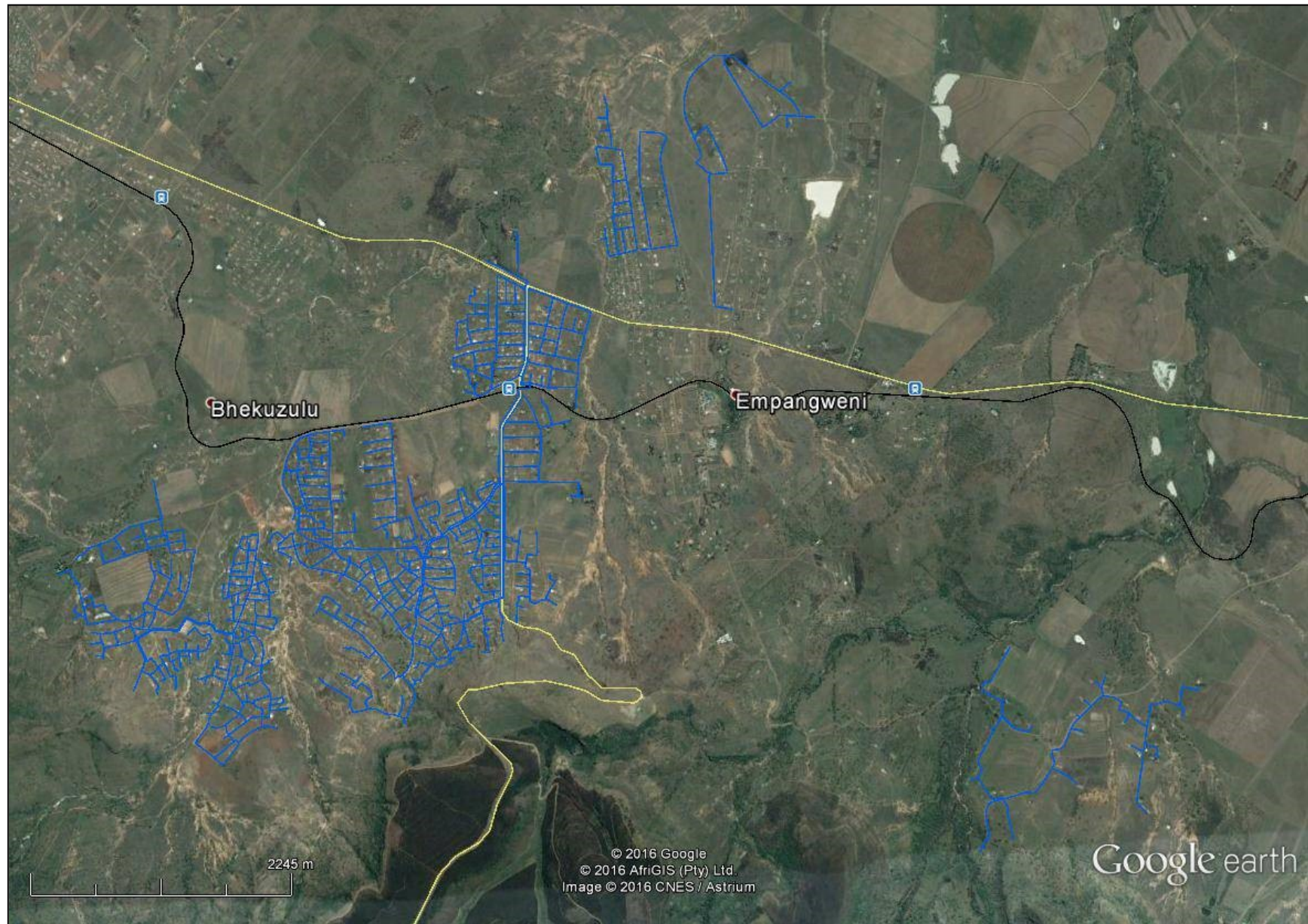
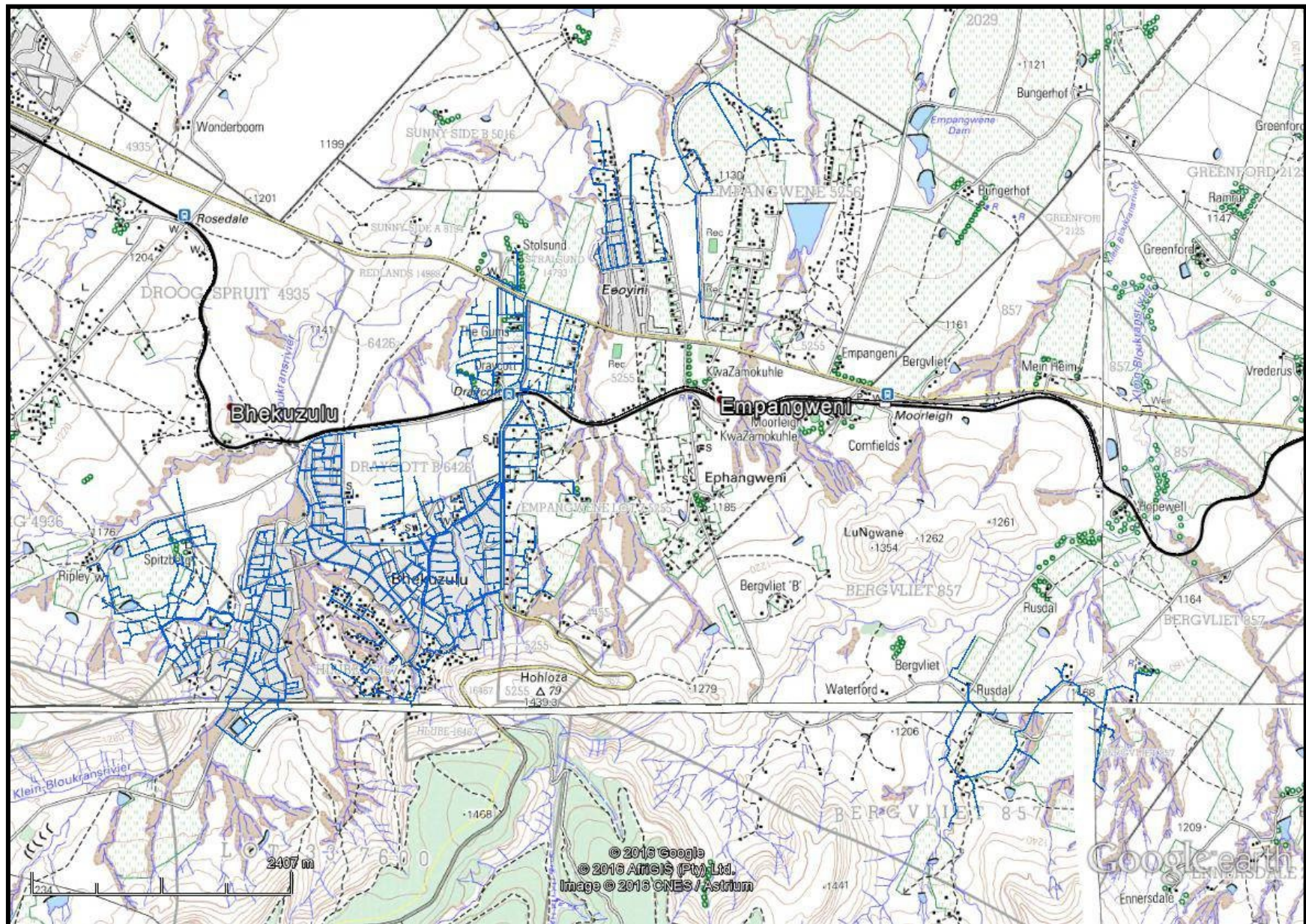




FIG. 3: TOPOGRAPHICAL OVERVIEW OF THE STUDY AREA





**FIG. 4: SCENIC VIEWS OF THE PIPELINE ROUTE**





FIG. 5: VIEWS OF VARIOUS OFFTAKES





FIG. 6: VIEWS OF VARIOUS OFFTAKES



## 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 1<sup>st</sup> and 2<sup>nd</sup> 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. 5). These sites include all types of Stone Age and Iron Age sites. No systematic archaeological and heritage impact assessments have been undertaken in the study area. Several archaeological sites have been recorded in and nearby the study area. These include: 2829DC006 (MSA scatter), 2929BA012 (LSA scatter) and 2829DC 010 (rock art). The first two sites are general scatters of stone tools as would be expected in the area. These types of sites occur across the landscape and are of low significance. The rock art site is outside of the study area besides a tar road. The site will not be affected.

No national monuments, battlefields, or historical cemeteries are known to occur in the study area.

The Surveyor General maps indicate that the first farms were proclaimed in 1852 (fig.'s 8 – 10). The Farm Boschoek consisted of many small plots/stands that were surveyed in 1938. By 1942, there are several clusters of settlements in the area that are systematically farmed for crops (fig. 11). Bergvliet 857 was surveyed in 1868, and the farmhouse is indicated on the map (fig. 10).

## **FIELD SURVEY**

No heritage sites were observed along the route. The small Stone Age sites previously recorded are small open scatters that have been subsequently dispersed. These are of low significance and commonly occur on the landscape.

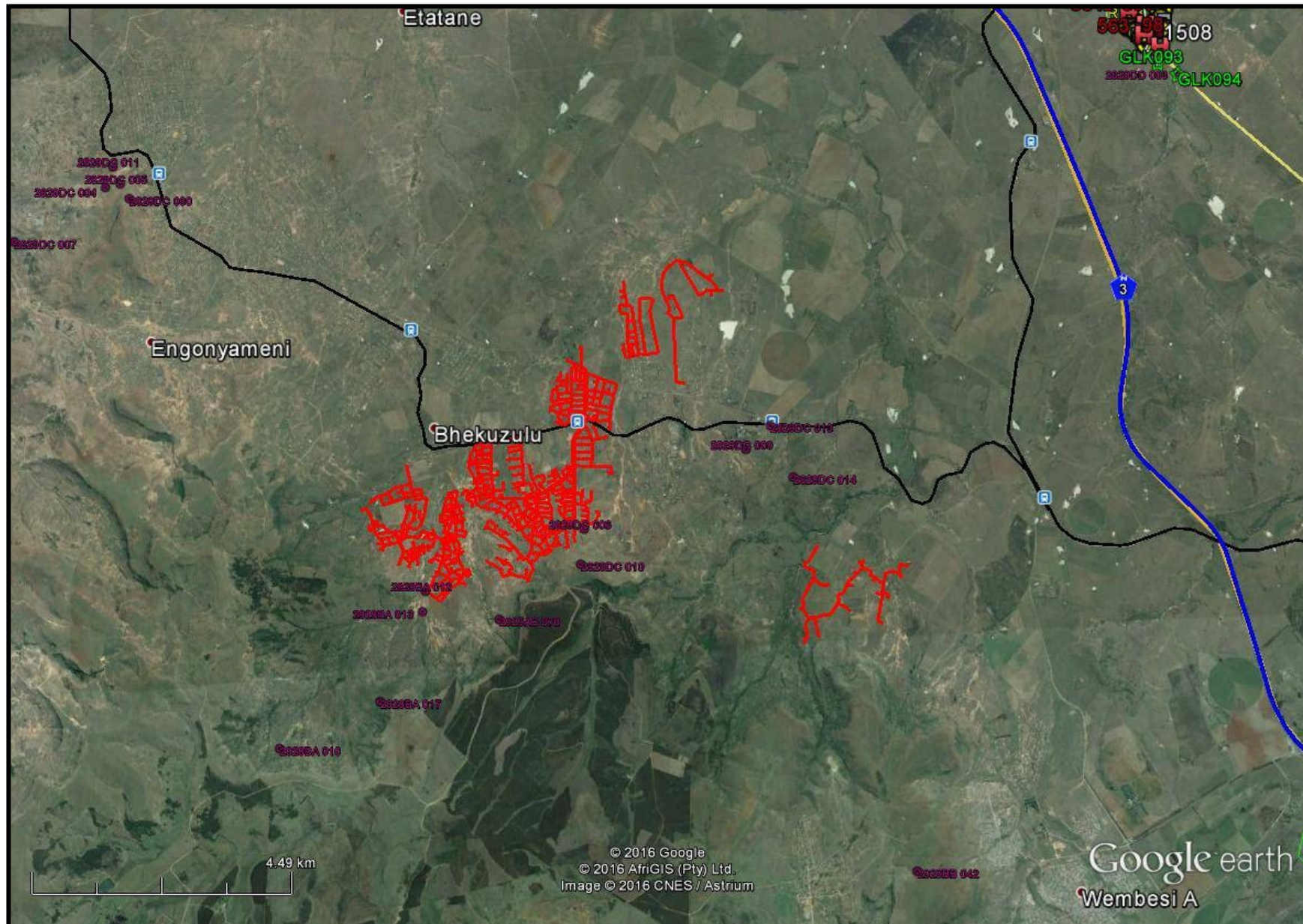
### **Bergvliet 857**

The Farm Bergvliet 857 dates back to at least 1868, and the house occurs on that Surveyor General Diagram. There have been several additions to the original farmhouse and the basic structure still remains, while the rest is in ruins. This is unfortunate as it would be one of the older farmhouses in the area. Fig. 12 shows the remains of the farmhouse.

**Significance:** The house would need to be assessed if affected. The pipelines do not currently affect the house directly.

**Mitigation:** If any middens (rubbish dumps) are exposed near the house during construction, then this needs to be reported to an HIA person and/or Amafa KZN.

FIG. 7: LOCATION OF KNOWN HERITAGE SITES NEAR THE STUDY AREA





**FIGURE 8: SURVEYOR GENERAL FARM BOSCHOEK (1852)**

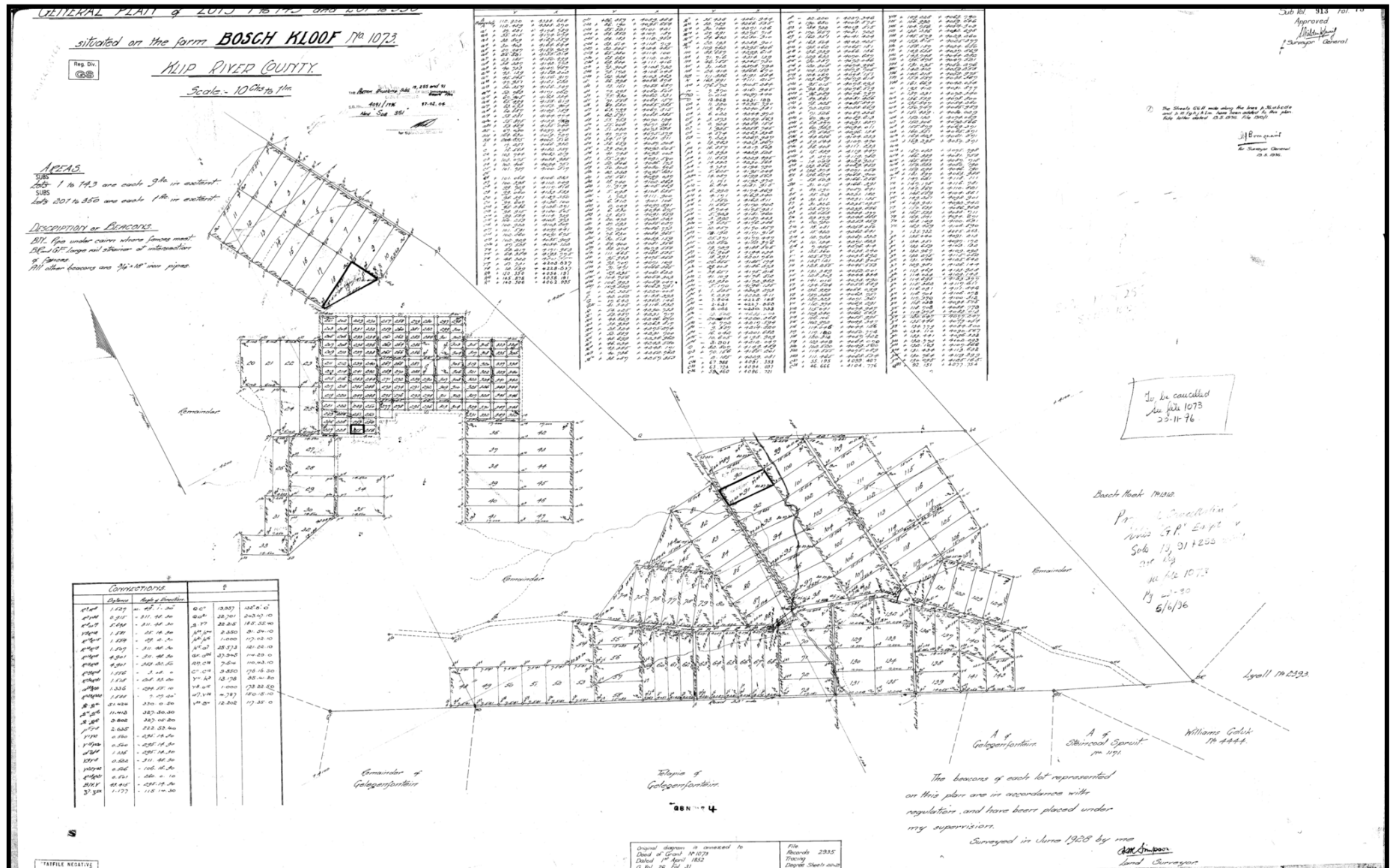


FIGURE 9: SURVEYOR GENERAL FARM DRAYCOT (1902)

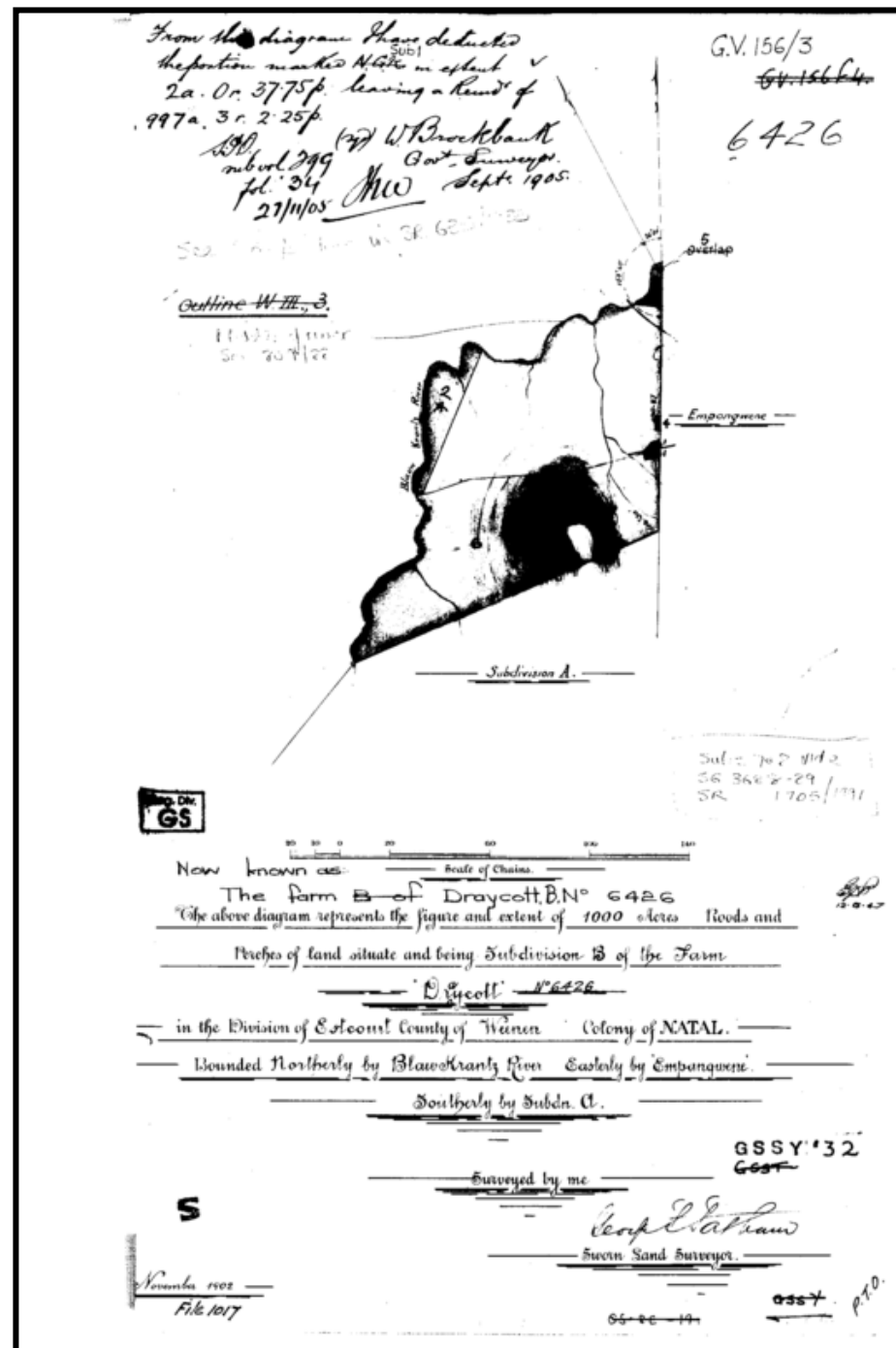


FIGURE 10: SURVEYOR GENERAL FARM BERGVLIET 857(1862)

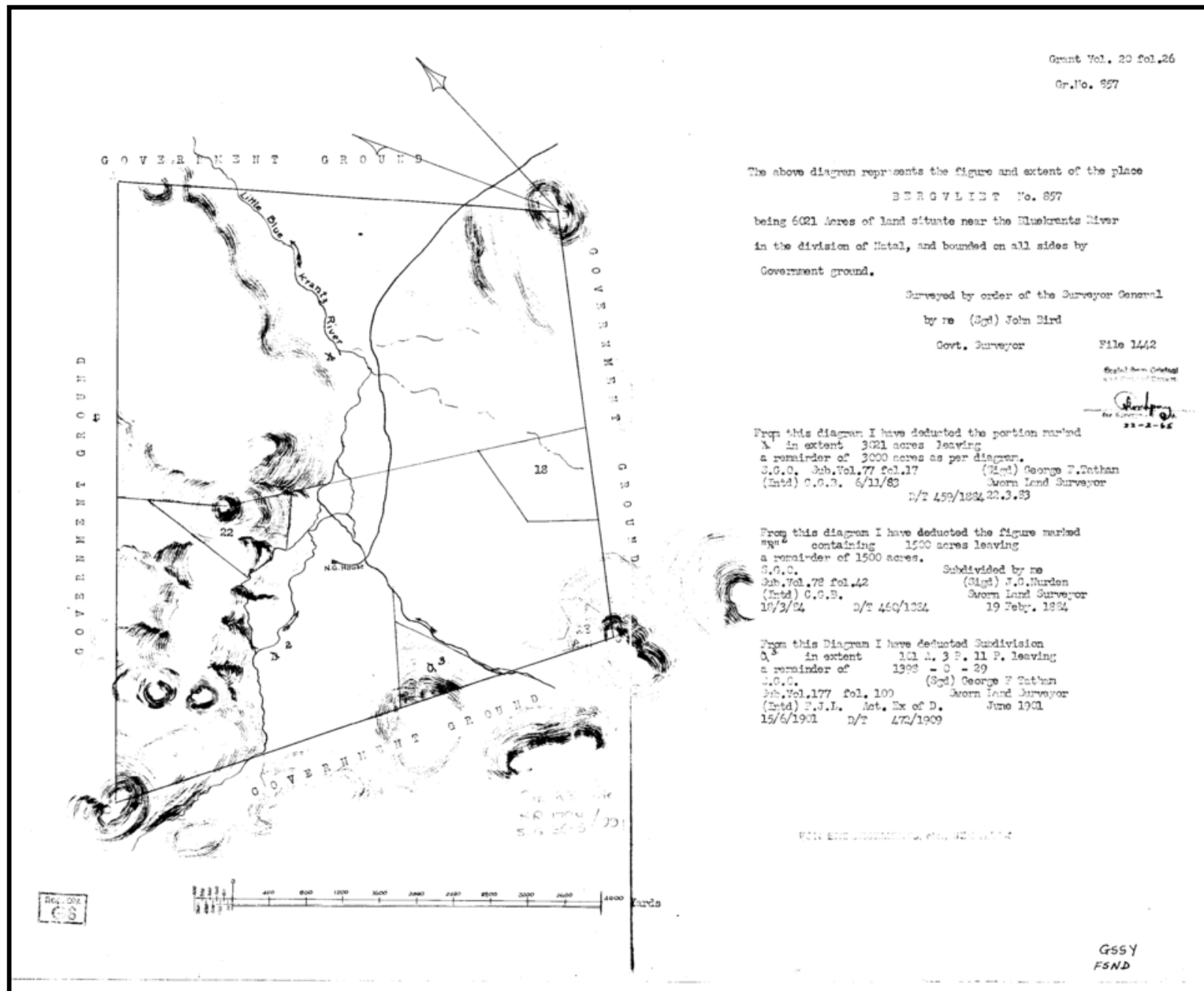
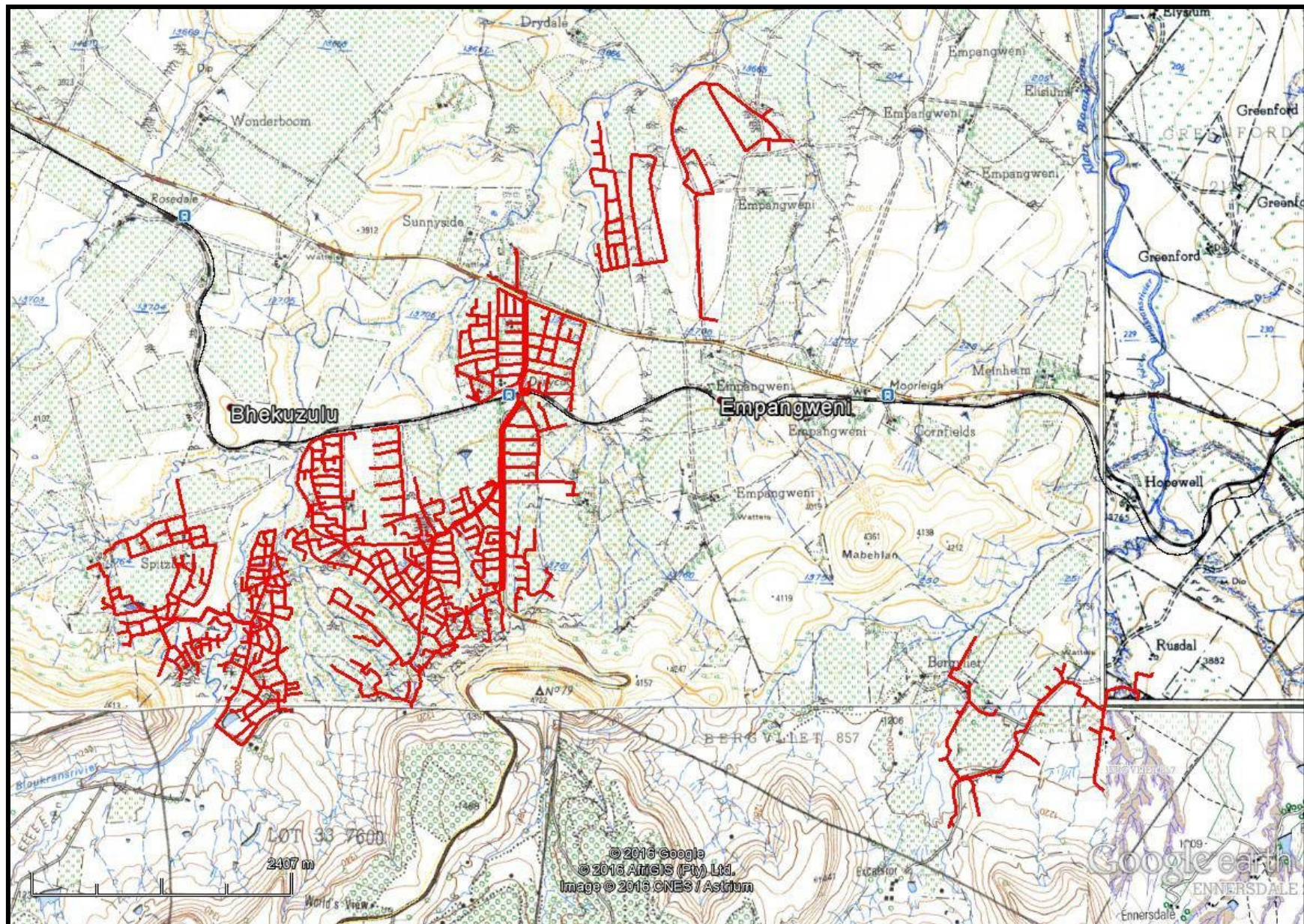




FIG. 11: STUDY AREA IN 1942, and 1945





**FIG. 12: REMAINS OF FARM BERGVLIET 857**

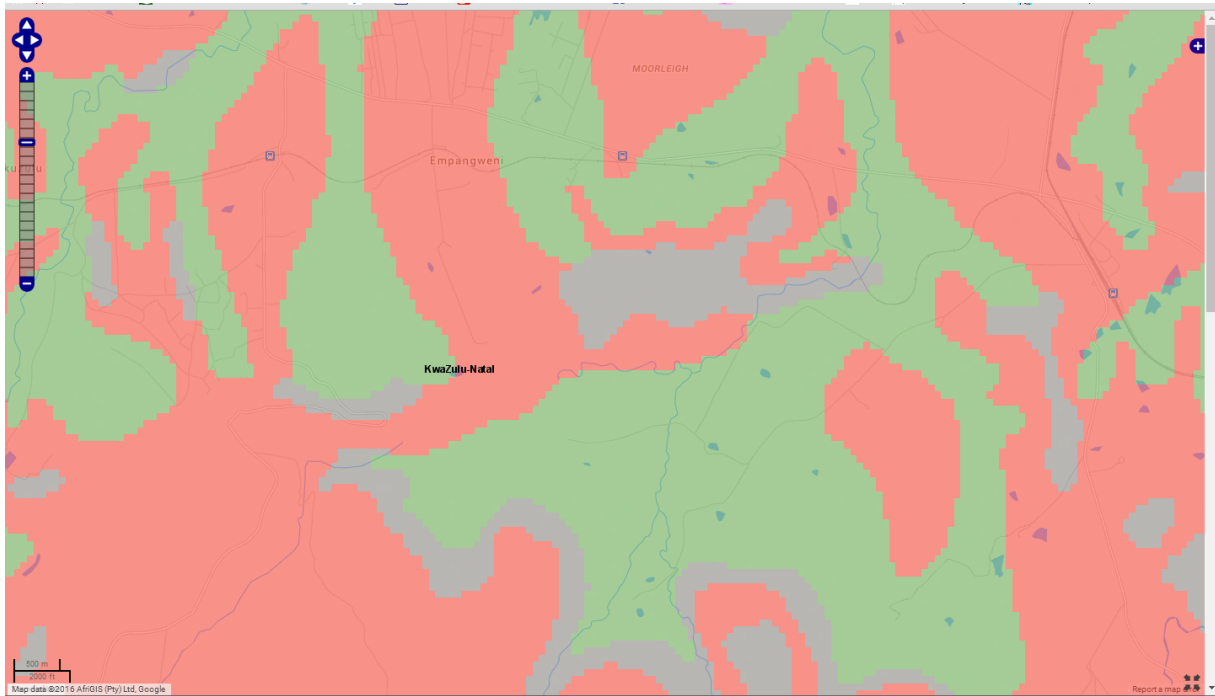


## PALAEONTOLOGICAL IMPACT ASSESSMENT

The proposed reticulation occurs in an area of medium to high palaeontological sensitivity (fig. 13). The complete PIA desktop assessment is given in Appendix A.

“The study area is underlain by sedimentary rocks of the Permian-aged Normandien Formation, Adelaide Subgroup, Jurassic aged Dolerite and Quaternary Masotcheni Formation as well as Alluvium deposits. A Very High Palaeontological Sensitivity is allocated to rocks of the Adelaide Subgroup due to the extremely rich fossil assemblages of the *Daptocephalus* and *Lystrosaurus* Assemblage Zones as well as highly significant plant fossils of the *Glossopteris* Assemblage and fossils of insect wings described from this unit. While no significant fossils have been described from the Masotcheni Formation or Alluvium deposits in this part of South Africa, significant fossils are known from similar deposits in other parts of the country and a Very High Palaeontological Sensitivity is therefore allocated to these areas due to the extreme likelihood that significant fossils will be exposed in all the gullies washed open and all excavations for the pipelines to depths of 1m and more. The development is located on middleslopes as well as on footslopes and along small water courses. It is highly likely that exposures of fossiliferous rocks that will be affected by the development and fossils might be exposed and destroyed during construction of the pipelines. A phase 1 PIA is therefore recommended before construction starts and a Phase 2 Palaeontological Impact Assessment will most probably be recommended following the initial Phase 1 assessment” (Groenewald – Appendix A).



**FIG. 13: PALAEOONTOLOGICAL SENSITIVITY OF THE BWSS**

COLOUR	SENSITIVITY	REQUIRED ACTION
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	MODERATE	desktop study is required
BLUE	LOW	no palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	no palaeontological studies are required
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

## **CONCLUSION**

A heritage survey was undertaken for the Bhekuzulu, Epangweni and Ennersdale water supply scheme. Archaeological sites have been recorded in the general area, however they are open scatters of stone tools as opposed to a well defined site. These do not require further mitigation.

While there are several graves in the study area, all of these occur within the fenced off homes. They will thus not be affected by the pipeline.

The area is of high palaeontological sensitivity and will probably affect these sites. A Phase 1 palaeontological survey will be required prior to construction of the line. Further palaeontological work may be required during the construction phase. The developer will need to apply for a permit to damage palaeontological deposits.

**APPENDIX A**  
**PALAEONTOLOGICAL IMPACT DESKTOP STUDY**



**DESKTOP PALAEOLOGICAL  
ASSESSMENT FOR THE PROPOSED  
BHEKUZULU, EPANGWENI AND  
ENNERSDALE WATER SUPPLY SCHEME,  
IMBABAZANE LOCAL MUNICIPALITY,  
UTHUKELA DISTRICT MUNICIPALITY,  
KWAZULU-NATAL PROVINCE.**

**FOR  
Umlando**

**DATE: 07 April 2016**

**By**

**Gideon Groenewald  
Cell: 078 713 6377**

## EXECUTIVE SUMMARY

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential Palaeontological Impact of the proposed development of the Bhekuzulu, Epangweni and Ennersdale Water Supply Scheme, Imbabazane Local Municipality, Uthukela District Municipality, Kwazulu-Natal Province

The proposed water supply scheme will cover a total estimated land footprint of 70km<sup>2</sup> with an estimated real footprint (2m route width of pipelines) estimated at 24km<sup>2</sup>. The pipeline will vary from 50mm to 250mm diameter and trenching will be average 1.1m deep to 1.5m deep with a maximum width of 700mm.

The study area is underlain by sedimentary rocks of the Permian-aged Normandien Formation, Adelaide Subgroup, Jurassic aged Dolerite and Quaternary Masotcheni Formation as well as Alluvium deposits. A Very High Palaeontological Sensitivity is allocated to rocks of the Adelaide Subgroup due to the extremely rich fossil assemblages of the *Daptocephalus* and *Lystrosaurus* Assemblage Zones as well as highly significant plant fossils of the *Glossopteris* Assemblage and fossils of insect wings described from this unit. While no significant fossils have been described from the Masotcheni Formation or Alluvium deposits in this part of South Africa, significant fossils are known from similar deposits in other parts of the country and a Very High Palaeontological Sensitivity is therefore allocated to these areas due to the extreme likelihood that significant fossils will be exposed in all the gullies washed open and all excavations for the pipelines to depths of 1m and more. The development is located on middleslopes as well as on footslopes and along small water courses. It is highly likely that exposures of fossiliferous rocks that will be affected by the development and fossils might be exposed and destroyed during construction of the pipelines. A phase 1 PIA is therefore recommended before construction starts and a Phase 2 Palaeontological Impact Assessment will most probably be recommended following the initial Phase 1 assessment.

### Recommendations:

1. The EAP and ECO of the projects must be informed of the fact that highly significant fossils have been described from the Normandien Formation. The recording of fossils will contribute very significantly to our understanding of the palaeo-environments of this region.
2. A suitably qualified Palaeontologist must be appointed to record and collect fossils according to SAHRA and AMAFA specifications as part of a Phase 1 Palaeontological Impact Assessment before and also during excavation of all the trenches except in the few areas underlain by dolerite.
3. These recommendations must form part of the EMP for the project.

## TABLE OF CONTENT

<u>EXECUTIVE SUMMARY</u> .....	28
<u>Recommendations:</u> .....	28
<u>TABLE OF CONTENT</u> .....	29
<u>INTRODUCTION</u> .....	30
<u>SOUTH AFRICAN NATIONAL HERITAGE RESOURCE ACT NO 25/1999 AND</u>	
<u>KWAZULU-NATAL HERITAGE ACT NO 4/2008</u> .....	30
<u>METHODOLOGY</u> .....	31
<u>GEOLOGY</u> .....	34
<u>Adelaide Subgroup</u> .....	34
<u>Dolerite (Jd)</u> .....	35
<u>Masotcheni Formation (Qm)</u> .....	35
<u>PALAEONTOLOGY</u> .....	35
<u>Adelaide Subgroup [Normandien Formation]</u> .....	35
<u>Dolerite</u> .....	36
<u>Masotcheni Formation and Alluvium</u> .....	36
<u>DISCUSSION</u> .....	36
<u>MANAGEMENT PLAN</u> .....	36
<u>CONCLUSION AND RECOMMENDATIONS</u> .....	38
<u>Recommendations:</u> .....	38
<u>REFERENCES</u> .....	39
<u>QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR</u> .....	41
<u>DECLARATION OF INDEPENDENCE</u> .....	41

## TABLE OF FIGURES

<u>Figure 1 Bhhekuzulu Water Reticulation Project Site Plan</u> .....	30
<u>Figure 2 The study area is underlain by the Permian to Triassic aged Adelaide</u>	
<u>Subgroup (Pes, Normandien Formation, green), Jurassic aged Dolerite</u>	
<u>(pink) and the Quaternary aged Masotcheni Formation (Qm -yellow).</u> .....	34
<u>Figure 3 The entire study area is allocated a Very High Palaeontological</u>	
<u>sensitivity since very small areas are underlain by dolerite. For colour coding</u>	
<u>see Table 1.</u> .....	38

## LIST OF TABLES

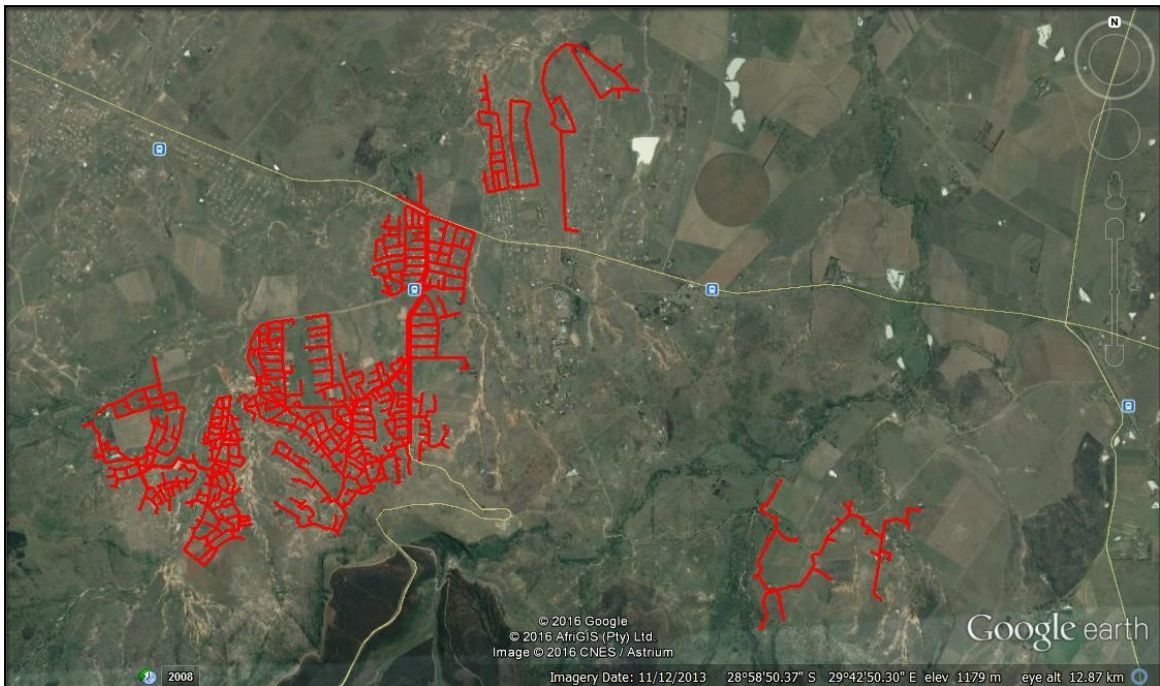
<u>Table 1 Palaeontological sensitivity analysis outcome classification</u> .....	32
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## INTRODUCTION

Gideon Groenewald was appointed to undertake a desktop survey, assessing the potential Palaeontological Impact of the proposed development of the Bhhekuzulu, Epangweni and Ennersdale Water Supply Scheme, Imbabazane Local Municipality, Uthukela District Municipality, Kwazulu-Natal Province (figure 1).

The proposed water supply scheme will cover a total estimated land footprint of 70km<sup>2</sup> with an estimated real footprint (2m route width of pipelines) estimated at 24km<sup>2</sup>. The pipeline will vary from 50mm to 250mm diameter and trenching will be average 1.1m deep to 1.5m deep with a maximum width of 700mm.



**Figure 1 Bhhekuzulu Water Reticulation Project Site Plan**

## **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 bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

**Table 1 Palaeontological sensitivity analysis outcome classification**

<b>PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS</b>	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008, 2009) (Groenewald et al., 2014).	
<b>RED</b>	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction ) as well as application for collection and destruction permit compulsory.
<b>ORANGE</b>	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
<b>GREEN</b>	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.
<b>BLUE</b>	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance,



	and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Collection of a representative sample of potential fossiliferous material is recommended.
<b>GREY</b>	Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during emplacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits.

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 predominantly by Permian-aged rocks of the Adelaide Subgroup, Beaufort Group and Jurassic aged dolerite of the Karoo Supergroup as well as Quaternary-aged sediments of the Masotcheni Formation (Figure 2).

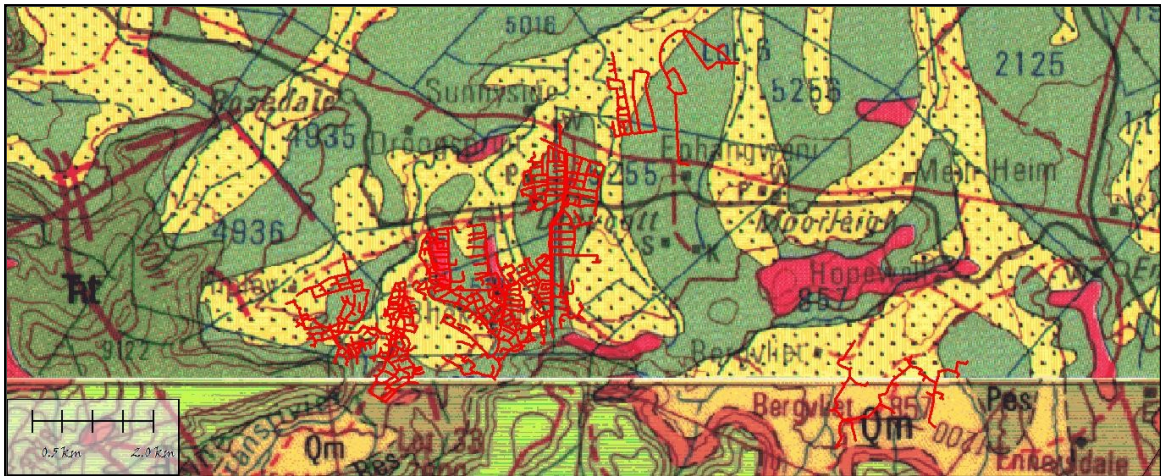


Figure 2 The study area is underlain by the Permian to Triassic aged Adelaide Subgroup (Pes, Normandien Formation, green), Jurassic aged Dolerite (pink) and the Quaternary aged Masotcheni Formation (Qm -yellow).

### Adelaide Subgroup

The Permian aged Adelaide Subgroup comprises the lower part of the Beaufort Group along the Drakensberg Escarpment and on some 1:250 000 sheets is referred to as the Adelaide Formation. In most of the outcrop areas in KwaZulu-Natal the Adelaide Subgroup consists primarily of a lower deltaic facies, mostly referred to as the Estcourt Formation (Pes) and an upper fluvial facies

referred to as the Normandien Formation (Pne) (Groenewald, 1984; Johnson et al 2009). Recently there is consensus to refer to the entire Adelaide Subgroup as the Normandien Formation and includes a very well defined brightly coloured (red and green) mudstone and siltstone known as the Harrismith Member in this part of the Karoo Basin. This unit of red mudstone is more well-known as the Palingkloof Member in the southern part of the Karoo Basin.

The Normandien Formation represents the northward and westward migration of deltaic environments in the east, followed by fluvial environments into the Karoo Basin to the west of the study area. The Formation consists of a sequence of interbedded deltaic to fluvial and lacustrine sandstones and mudstone with a prominent sandstone referred to as the Schoondraai Member in the study area. This sandstone unit is an important marker horizon and coincides most probably with the important Permian Extinction event of 250 million years ago (Groenewald, 1990; Johnson et al. 2009).

### **Dolerite (Jd)**

Jurassic aged dolerite sills and dykes intruded the Karoo Supergroup sediments during the breakup of Gondwanaland and underlies small parts of the study area.

### **Masotcheni Formation (Qm)**

The Quaternary aged Masotcheni Formation consists of unconsolidated sediments and clay, comprising mostly of sandy to mud-rich sandy deposits on almost all the footslopes with proper alluvium restricted to areas along the major river and stream systems.

## **PALAEONTOLOGY**

### **Adelaide Subgroup [Normandien Formation]**

The Adelaide Subgroup now formally referred to as the Normandien Formation in this part of the Karoo Basin comprises the *Daptocephalus* (previously *Dicynodon*) Assemblage Zone (Viglietti et al., 2016; Groenewald, 1984, 1990, 1996; MacRae, 1999; McCarthy & Rubidge, 2005) as well as the overlying *Lystrosaurus* Assemblage Zone of the Karoo Supergroup (van der Walt et al, 2010; Modesto et al, 2010). The Adelaide Formation is well-known for extremely well preserved remains of plants, mainly the *Glossopteris* Assemblage and petrified wood is abundantly present in outcrops in the study area. It is also one of the few areas in South Africa where extremely well-preserved fossils of insect wings of Permian age are discovered (Groenewald, 1990).



The Schoondraai Member is a prominent sandy unit that invariably overlies the *Daptocephalus* Assemblage Zone and underlies the very well-known and fossil rich *Lystrosaurus* Assemblage Zone, associated with the easily identified Harrismith Member that consists characteristically of brightly coloured mudstone and siltstone in the study area. The *Lystrosaurus* Assemblage Zone is also known for containing well-defined casts of vertebrate burrows (Groenewald, 1996 and Modesto et al, 2010) The Normandien Formation is well-known for its richness in fossils and any exposure of the Formation will most probably produce highly significant fossils. Although the Permian/Triassic boundary still needs to be clarified in KZN, the study area falls well within this notoriously difficult palaeontological zone in KwaZulu-Natal and fossils from this area will certainly contribute significantly to the International database associated with this important extinction event of 250 million years ago (Viglietti et al, 2016).

### **Dolerite**

Due to the igneous nature of dolerite it will not contain any fossils.

### **Masotcheni Formation and Alluvium**

To date, no significant fossils have been described from the sandy and clayey deposits associated with the footslopes of the hills as well as the deposits along the streams and rivers of this part of KwaZulu-Natal. Significant fossils have however been reported from similar deposits in other parts of South Africa, as for example at Cornelia in the Free State Province 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. A variety of fossils have been described from the Permian to Triassic aged Adelaide Subgroup (Normandien Formation) and includes vertebrate fossils of the *Daptocephalus* and *Lystrosaurus* Assemblage Zones as well as plant fossils of the *Glossopteris* Assemblage with associated wings of insects. Invertebrate fossils include several small trace fossils as well as casts of vertebrate burrows. While no significant fossils have been described to date from the Masotcheni and alluvium deposits in this part of South Africa, any such finds would be highly significant.

## **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. 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 footprint. The Bhekuzulu Water Reticulation development site is located in a very highly sensitive palaeontological zone and all exposures or excavations might contain highly important fossil remains of Permian and Triassic age to Quaternary age, both on the middleslopes, footslopes and along small water courses and it is probable that Adelaide Subgroup rocks are exposed through erosion over the entire area of this development. The recording of fossils from the development site will have a highly significant impact on our understanding of the palaeo-environments in this part of Gondwanaland where relatively little information has been gathered to date. A Very High Palaeontological Sensitivity is allocated to all the sections underlain by rocks of the Normandien Formation. A Very High Palaeontological Sensitivity is also allocated to areas mapped as Masotcheni Formation due to the very high possibility of finding significant fossils in all the streams and erosion areas associated with this Formation. A Very Low Palaeontological Sensitivity is allocated to areas underlain by Dolerite as this rock type will not contain fossils. Due to the very small areas underlain by dolerite it is possible that fossil remains could be washed along streams that cross these exposures and the field study proposed for the Phase 1 assessment must include a walk through of all the areas impacted by this development. The palaeontological sensitivity of the study area is shown in Figure 3.

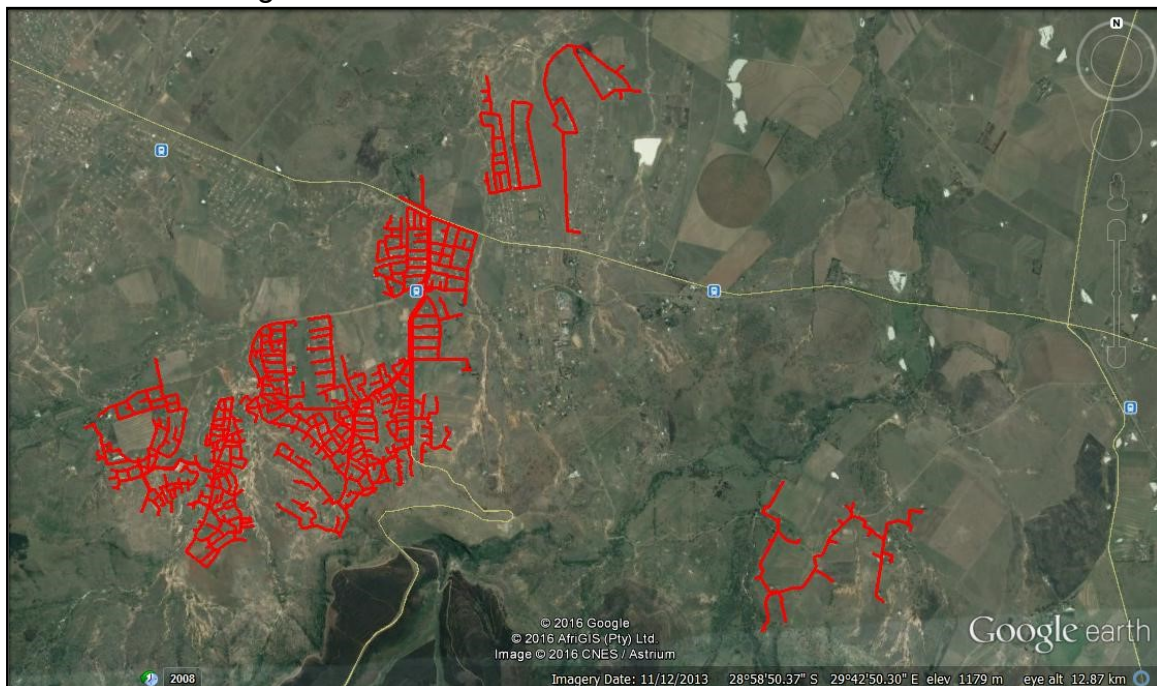


Figure 3 The entire study area is allocated a Very High Palaeontological sensitivity since very small areas are underlain by dolerite. For colour coding see Table 1.

## CONCLUSION AND RECOMMENDATIONS

The study area is underlain by sedimentary rocks of the Permian-aged Normandien Formation, Adelaide Subgroup, Jurassic aged Dolerite and Quaternary Masotcheni Formation as well as Alluvium deposits. A Very High Palaeontological Sensitivity is allocated to rocks of the Adelaide Subgroup due to the extremely rich fossil assemblages of the *Daptocephalus* and *Lystrosaurus* Assemblage Zones as well as highly significant plant fossils of the *Glossopteris* Assemblage and fossils of insect wings described from this unit. While no significant fossils have been described from the Masotcheni Formation or Alluvium deposits in this part of South Africa, significant fossils are known from similar deposits in other parts of the country and a Very High Palaeontological Sensitivity is therefore allocated to these areas due to the extreme likelihood that significant fossils will be exposed in all the gullies washed open and all excavations for the pipelines to depths of 1m and more. The development is located on middleslopes as well as on footslopes and along small water courses. It is highly likely that exposures of fossiliferous rocks that will be affected by the development and fossils might be exposed and destroyed during construction of the pipelines. A phase 1 PIA is therefore recommended before construction starts and a Phase 2 Palaeontological Impact Assessment will most probably be recommended following the initial Phase 1 assessment.

### Recommendations:

- 3 The EAP and ECO of the projects must be informed of the fact that highly significant fossils have been described from the Normandien Formation. The recording of fossils will contribute very significantly to our understanding of the palaeo-environments of this region.
- 4A suitably qualified Palaeontologist must be appointed to record and collect fossils according to SAHRA and AMAFA specifications as part of a Phase 1 Palaeontological Impact Assessment before and also during excavation of all the trenches except in the few areas underlain by dolerite.
- 5 These recommendations must form part of the EMP for the project.



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compilation of stratigraphic ranges.

## **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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