DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT ON THE SITE OF THE PROPOSED MARAPONG TOWNSHIP EXTENSION PROJECT, INCLUDING A BULK SEWER LINE, NEAR LEPHALALE, LIMPOPO PROVINCE

11 July 2017

Prepared for:

Heritage Contracts and Archaeological Consulting CC.

On behalf of:

Tekplan Environmental

Postal address:
P.O. Box 13755
Hatfield
0028
South Africa

Cell: +27 (0) 79 626 9976
Faxs:+27 (0) 86 678 5358
E-mail: bmgeoserv@gmail.com

DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT ON THE SITE OF THE PROPOSED MARAPONG TOWNSHIP EXTENSION PROJECT, INCLUDING A BULK SEWER LINE, NEAR LEPHALALE, LIMPOPO PROVINCE

Prepared for:

Heritage Contracts and Archaeological Consulting CC.

On behalf of:

Tekplan Environmental

Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

It is proposed to construct an extension of the existing Morapong township on a site near Lephalale in the Limpopo Province. The proposed township development is located approximately 12 km west of Lephalale on Portion 1 and the Remaining Extent of the farm Nelsonskop 464 LQ, Magisterial District of Lephalale. The project area lies immediately to the north-west of the Morapong township, 1 km to the north of Matimba Powerstation, 2 km east of the Grootegeluk Coalmine. The aerial extent of the proposed project is approximately 220 Ha. The route of an approximately 2.8 km long bulk sewer line extends eastwards from within the township extension area and also forms part of the project. The sewer line extends approximately 2.4 km outside the township area. The exact footprint of the area that will be underlain by the pipeline is assumed to be less than 10 m wide. Accordingly, the aerial extent of the area that will potentially be impacted by the pipeline external to the demarcated township development is 24 000 m^2.

Teklplan Environmental has appointed Heritage Contracts and Archaeological Consulting CC to conduct an Archaeological Impact Assessment for the proposed Nelsonskop Farm Township Development as part of the Basic Assessment. Heritage Contracts and Archaeological Consulting CC has appointed BM Geological Services to provide a Desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project.

Precious work in the immediate region by the author suggests that only minimal outcrops of bedrock will be present, if any, within the project area (due to the ubiquitous regolith cover). However, published geological data suggests the regolith cover is underlain by sedimentary rocks of the Swartrant and Clarens Formations of the Karoo Supergroup and lavas of the Jurassic Letaba Formation.

The potential for a negative impact on the fossil heritage of the area can be quantified in the following manner. The probability of a negative impact on the palaeontological heritage of the Cenozoic regolith is assessed as low as is that for the Clarens Formation. Where plant macrofossil assemblages are located they frequently contain dense accumulations and so often plant macrofossils are more commonly encountered than vertebrate fossils; as such the potential for negative impact upon the floras of the Swartrant Formation is assessed as medium. The potential for any negative impacts posed by the proposed project on the palaeontological heritage of the Letaba formation is assessed as being nil. Despite the low to medium potential for a negative impact upon the palaeontological heritage of the Karoo Supergroup rocks and the low probability of an impact upon the Cenozoic regolith, these units (or their stratigraphic equivalents) are known elsewhere to contain fossil faunas and floras of the highest scientific and cultural significance elsewhere in South Africa. As a result any negative impact could be of high significance.

The project has been assessed as being socially beneficial, herein, as it would provide accommodation and a community to low income people. The possibility of any negative impact on the palaeontological heritage of the project area could be minimised by the implementation of the following damage mitigation procedures:

- An appropriate staff member (e.g., the environmental officer) of the company responsible for the construction process be trained in recognition of the types of fossils that may be expected to be encountered in the envisioned excavations.
- The relevant employee should make regular and thorough examinations of all excavations that occur within the sediments of the Karoo Supergroup and Cenozoic regolith.
- Should any fossil materials be identified, the excavations in that area should be halted in that location and SAHRA informed of the discovery (see Section 3.4 above).
- A palaeontologist must then be appointed by the company to evaluate the fossil deposits and make the necessary recommendations regarding damage mitigation of the fossils materials.
- The excavations associated with the project should be inspected by a palaeontologist 2 times a year (i.e., once every 6 months) while they are occurring to ensure that no fossil materials are being damaged or destroyed.

A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

In summary, this study has not identified any palaeontological reason to prejudice the construction of the Marapong Township extension or the associated bulk sewer line, subject to adequate mitigation programs being put in place.

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

It is proposed to construct an extension of the existing Morapong township on a site near Lephalale in the Limpopo Province. The proposed township development is located approximately 12 km west of Lephalale on Portion 1 and the Remaining Extent of the farm Nelsonskop 464 LQ, Magisterial District of Lephalale. The project area lies immediately to the north-west of the Morapong township, 1 km to the north of Matimba Powerstation, 2 km east of the Grootegeluk Coalmine. The aerial extent of the proposed project is approximately 220 Ha. The route of an approximately 2.8 km long bulk sewer line extends eastwards from within the township extension area and also forms part of the project. The sewer line extends approximately 2.4 km outside the township area. The exact footprint of the area that will be underlain by the pipeline is assumed to be less than 10 m wide. Accordingly, the aerial extent of the area that will potentially be impacted by the pipeline external to the demarcated township development is 24 000 m^2.

Teklplan Environmental has appointed Heritage Contracts and Archaeological Consulting CC to conduct an Archaeological Impact Assessment for the proposed Nelsonskop Farm Township Development as part of the Basic Assessment. Heritage Contracts and Archaeological Consulting CC has appointed BM Geological Services to provide a Desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study were as follows:-

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

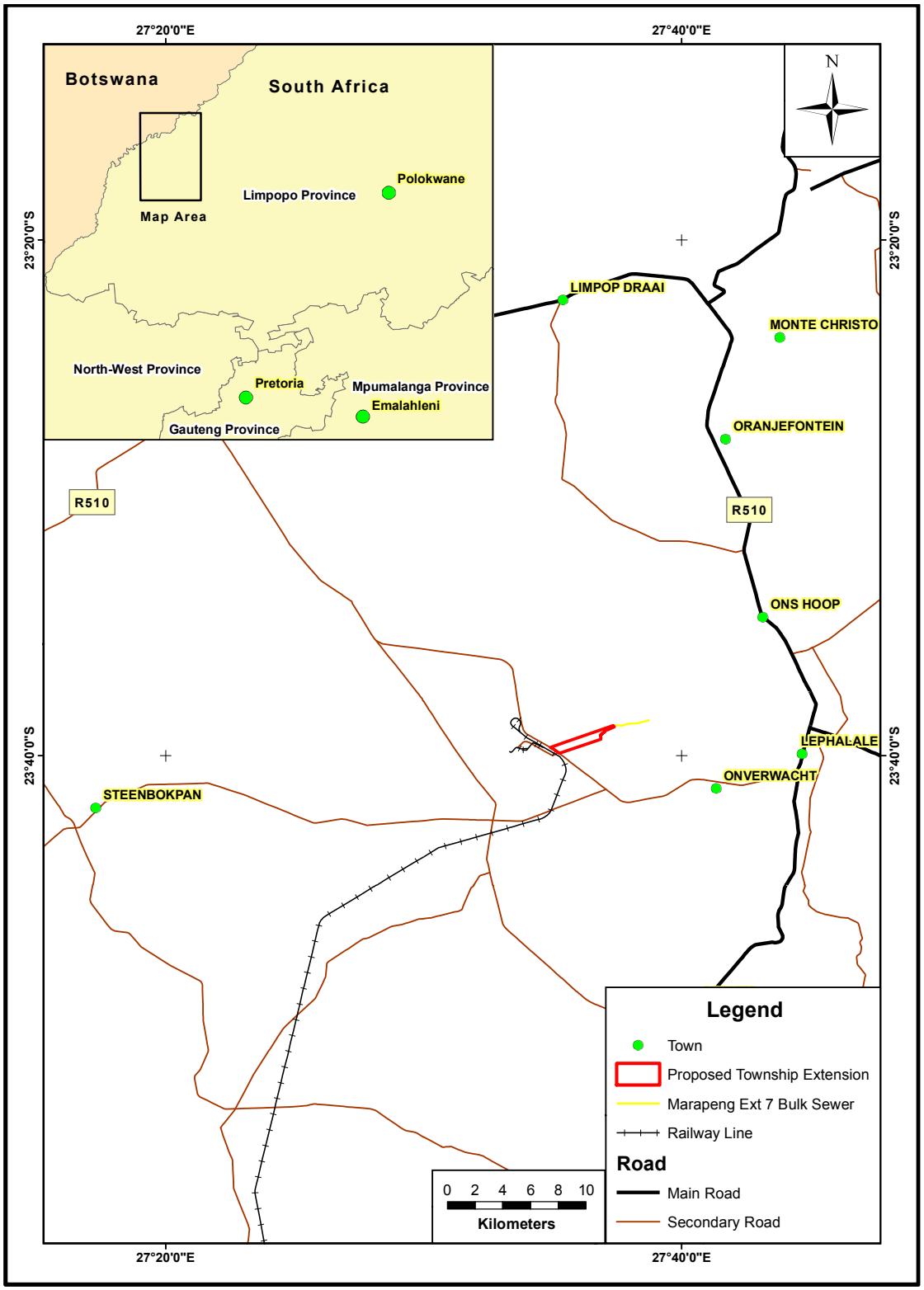

Figure 1: Map showing the location of the proposed Marapong Township extension project and associated bulk sewer line.

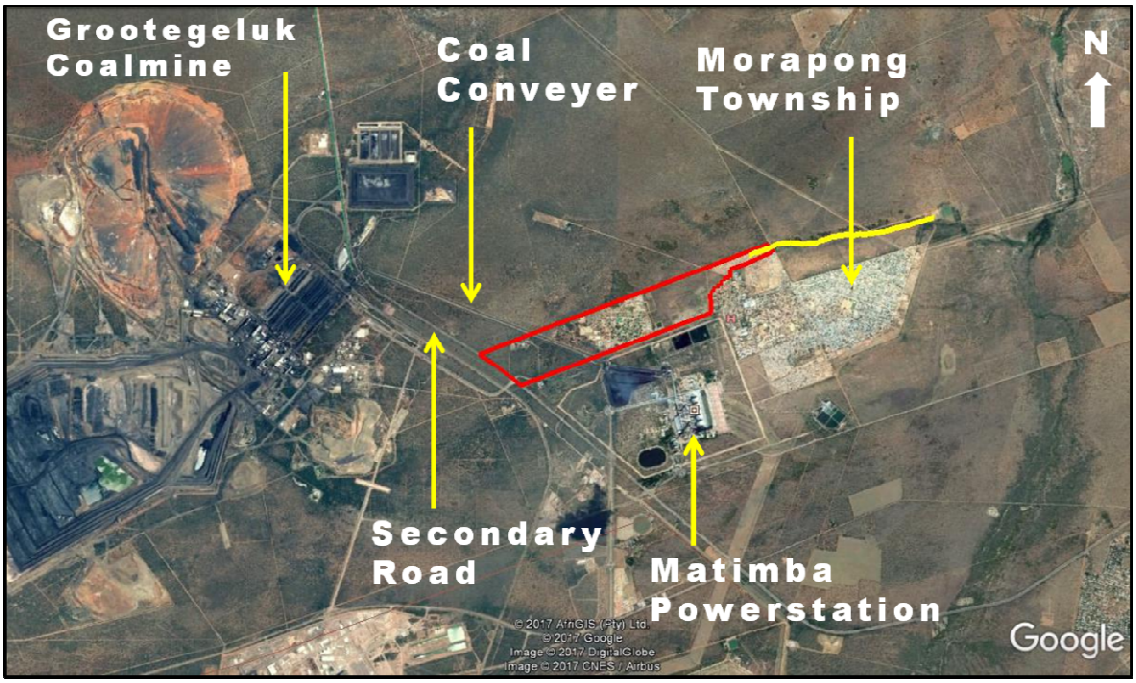

Figure 2: Google earth image showing the location of the proposed township extension project (red polygon) and bulk sewer line (yellow line) in relation to the existing Marapong Township, Grootegeluk Coalmine and the Matimba Power Station.

3 LEGISLATIVE REQUIREMENTS

South Africa's cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

3.1 The National Heritage Resources Act

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures and sites older than 100 years,
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography,
- Objects of decorative and visual arts,
- Military objects, structures and sites older than 75 years,
- Historical objects, structures and sites older than 60 years,
- Proclaimed heritage sites,
- Grave yards and graves older than 60 years,
- Meteorites and fossils,
- Objects, structures and sites or scientific or technological value.

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures and equipment of cultural significance,
- Places to which oral traditions are attached or which are associated with living heritage,
- Historical settlements and townscapes,
- Landscapes and features of cultural significance,
- Geological sites of scientific or cultural importance,
- Sites of Archaeological and palaeontological importance,
- Graves and burial grounds,
- Sites of significance relating to the history of slavery,
- Movable objects (e.g., archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

3.2 Need for Impact Assessment Reports

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300 m in length,
- The construction of a bridge or similar structure exceeding 50 m in length,
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof,
- Re-zoning of a site exceeding 10 000 m^2,
- Any other category provided for in the regulations of SAHRA or a provincial heritage authority,

must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development palaeontological resources of the proposed area to be affected.

3.3 Legislation Specifically Pertinent to Palaeontology*

***Note:** Section 2 of the Act defines "palaeontological" material as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains".

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite,
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite,
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned palaeontological objects may only be disturbed or moved by a palaeontologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that "any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act [as amended]

This Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but is more general in is application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns and, amongst other issues, serve their cultural interests equitably. Further to this point section 2(4)(a)(iii) states that disturbances of sites that constitute the nation's cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 RELEVENT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African and a Fellow the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted to conduct this Palaeontological Heritage Impact Assessment study as an independent consultant and shall receive fair remuneration for these professional services. Neither Prof Millsteed nor BM Geological Services has any financial interest in the proposed township project or any associated persons or companies.

6 GEOLOGY AND FOSSIL POTENTIAL

Figure 3 show that the township development area is underlain by the strata of several geological sequences that in part constitute the basin fill succession of the Ellisras Basin and the Waterberg Basin. The oldest of the bedrock units is found in the western half of the project area and consists of Early Permian sedimentary rocks of the Swartrant Formation (Karoo Supergroup). The younger bedrock lithological sequence is found in the western half of the study area and is composed of Late Triassic/Early Jurassic sedimentary rocks of the Clarens Formation (Karoo Supergroup) and Jurassic lavas of the Letaba Formation (Lebombo Group). The route of the proposed bilk sewer line is completely underlain by rocks of the Swartrant Formation. The majority of the land surface is essentially flat lying and is extensively overlain by a regolith composed of coarse-grained, unconsolidated Cenozoic sands. Outcrops of bedrock units are very rare, and the most significant by far is an exposure of the Clarens Formation that forms the nearby isolated hill known as Nelsons Kop (Figure 4). The Daarby Fault traverses the central portion of the project area in a north-east to south-west direction (Figure 3); where it separates the strata of the Swartrant Formation from the younger Jurassic rocks of the Clarens Formation and the Letaba Formation. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

6.1 Karoo Supergroup

6.1.1 Introduction

Rock units belonging to the Karoo Supergroup that underlie the project area include the Early Permian Swartrant and Late Triassic/Early Jurassic Clarens Formation. A brief description of the possible Karoo Supergroup units that may be present within the study area and their palaeontological potential follows.

6.1.2 Swartrant Formation

6.1.2.1 Geology

The Early Permian Swartrant Formation attains a maximum known thickness of 130 m in the central parts of the basin. It has been stratigraphically subdivided into lower, middle and upper zones based on borehole intersections. The lower zone consists of 6–10 m of alternating sandstone and siltstone overlain by flaser-bedded and ripple cross-bedded sandstones, which are in turn overlain by 17-26 m of coarse-grained, cross bedded sandstones. The top of the lower zone is comprised of a 1 m thick coal seam. The lower zone is believed to represent deposition in a delta front environment with provenience from the east (Johnson *et al*., 2006).

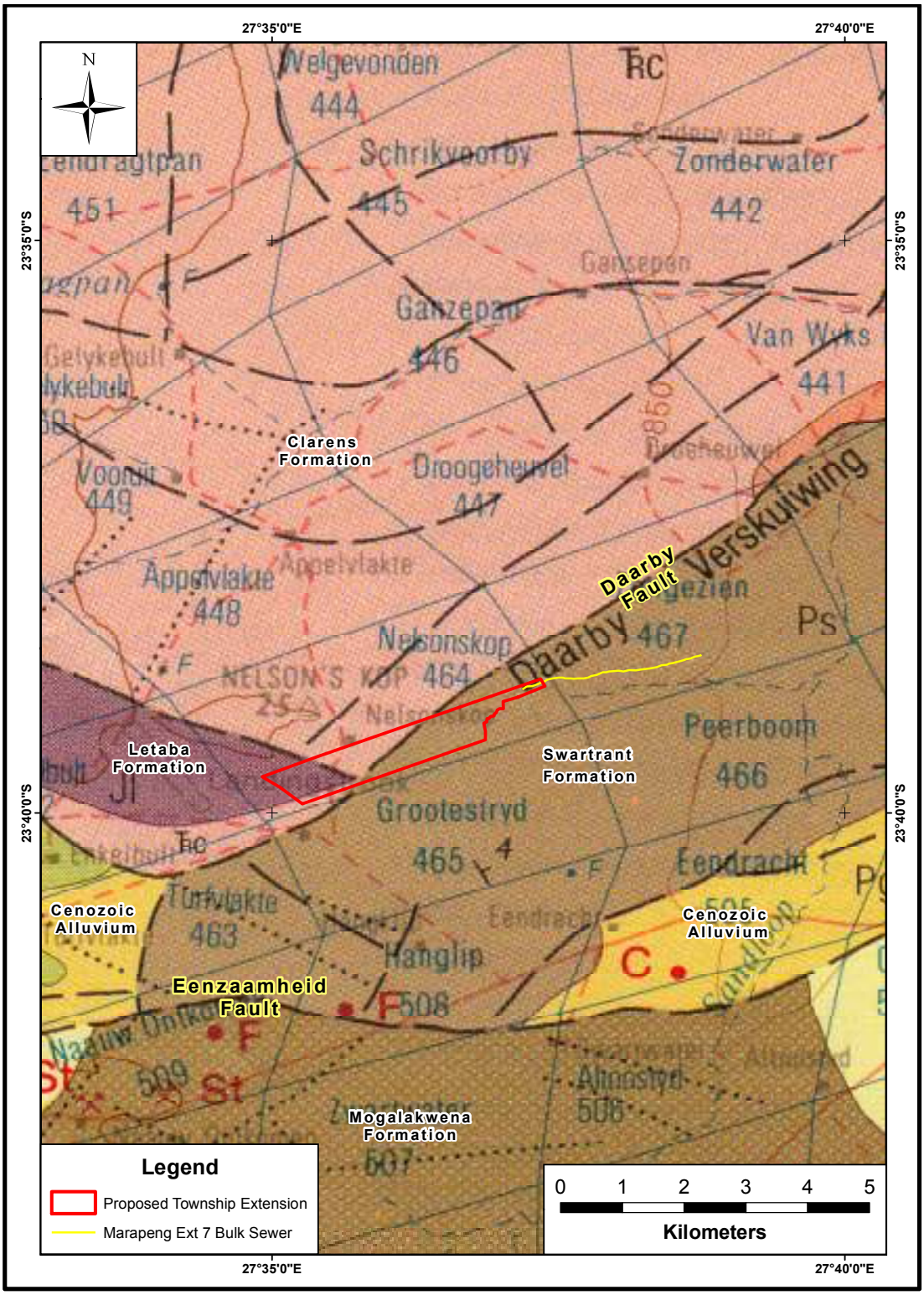

Figure 3: Detailed geological map showing the aerial extent of the geological units that underlie the proposed project infrastructure [modified from the 1:250 000 Geological Series Sheet 2326 Ellisras (Geological Survey of South Africa, 1993)].

The middle zone attains a maximum thickness of 15 m and comprises coarse-grained sandstone overlain by grey laminated mudstones. This zone is capped by up to 6 m of alternating coal and mudstone (Johnson *et al*., 2006). The majority of this zone is believed to have been deposited in a glaciolacustrine environment, with occasional dropstones indicating the presence of scattered icebergs.

The upper zone is up to 36 m thick and grades upwards from coarse-grained, white sandstone at the base to a 6 m thick mudstone unit. The coarse sandstones of the upper zone can be interpreted as fluvial channel fills, with the mudstone unit being deposited in the low-energy interchannel area (Johnson *et al*., 2006).

6.1.2.2 Palaeontological potential

The Swartrant Formation should be expected to contain plant macrofossils of the scientifically significant *Glossopteris* flora. The plant macrofossil assemblages to be expected within the Early Permian strata of South Africa have been summarised by Bamford (2004).

6.1.3 Clarens Formation

6.1.3.1 Geology

The Late Triassic/Early Jurassic Clarens Formation attains a maximum thickness of 130 m and is composed almost entirely of massive, well sorted, mostly cream coloured, fine-grained sandstones comprised of well rounded quarts grains. Most of the sandstone, particularly in the upper part is considered to be aeolian (Johnson *et al*., 2006). Minor coarse-grained detrital material contained within the unit was presumably transported by small, ephemeral streams.

6.1.3.2 Palaeontological potential

Significant fossils assemblages, but less diverse than those identified within the stratigraphically underlying Elliot Formation, have been reported within this unit and its lateral equivalents throughout South Africa and southern Zimbabwe. The vertebrate fossil assemblages of the Clarens Formation include dinosaurs (*Aristosaurus, Fabrosaurus, Geranosaurus, Gyposaurus, Heterodontosaurus, Hortalotarsus, Massospondylus and Thecodontosaurus*), sinapsid reptiles (*Pachygenelus and Tritylodon*) and a mammal (*Erythrotherium*) (Haughton, 1924; Raath, 1969; South African Committee for Stratigraphy (SACS), 1980; Olsen and Galton, 1984; Kitching and Raath, 1984; Weishampel *et al*., 1990). There have also been at least 10 different types of vertebrate footprints identified within the Clarens Formation and its lateral equivalents within South Africa (Van Dijk *et al*., 1978; Olsen and Galton, 1984).

Plant macrofossil fossils are uncommon with the formation and the assemblage is restricted to a single genus of sphenophyte (*Equisetum*) and the fossil wood *Podocarpoxylon* (Bamford, 2004).

These fossil (both plant and vertebrate) assemblages are uncommon and sporadic in their occurrence, but this rarity means that each fossil that does exist is potentially extremely scientifically significant.

6.2 Lebombo Group

6.2.1 Letaba Formation

6.2.1.1 Geology

The Letaba Formation (Lebombo Group) comprises a sequence of picritic (olivine-rich) lavas which form part of the Jurassic Karoo Igneous Province (Duncan and Marsh, 2006). The unit accordingly correlates with part of the Drakensberg Group lavas that terminate the Karoo Supergroup sedimentation in the Main Karoo Basin.

6.2.1.2 Palaeontological potential

The extrusive, magmatic origin of the rocks that comprise the Letaba Formation preclude the possibility of any fossil materials being present within the unit. Thus, the Lataba Formation has no palaeontological potential.

6.3 Cenozoic Regolith

6.3.1 Geology

Previous work in the region by the author has indicated that almost the entire extent of the flat-lying general area, is underlain by unconsolidated, coarse- to medium-grained, orange red to light brown, quartz rich Cenozoic sands. The maximum thickness of this sandy regolith is unknown, but the author has previously identified a shallow mining excavation elsewhere nearby in which approximately 1.5 of regolith profile is exposed.

6.3.2 Palaeontological potential

No fossil materials were located within this unit during the conduct of previous site investigations by the author in the immediate region. Given the coarse-grained and oxidised nature of these sediments it is unlikely that any biological materials incorporated into the sediments would have been preserved and fossilised, but the possibility cannot be discounted completely.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The site proposed for the construction of the Marapong Township extension project is large measuring approximately 4.2 km east-west and varying between 700 m wide at its western extent and 200 m wide along its eastern margin (approximately 220 ha). The route of an approximately 2.8 km long bulk sewer line extends eastwards from within the township extension area. The sewer line extends approximately 2.4 km outside the township area.

Examination of Google earth imagery (Figure 2) indicates that the project area lies immediately to the north-west of the Morapong township, 1 km to the north of Matimba Powerstation and 2 km east of the Grootegeluk Coalmine. Much of the central portion of the township project area contains a regularly laid out complex of built structures. A small (approx. 700 m x 700 m) square man-made dam is located near the south-eastern corner of the building complex. The narrow eastern-most extension of the area contains an extensive complex of irregularly arranged buildings that are indicative of informal development. A north-west to south-east oriented coal conveyer belt is located several hundred meters to the west of the central building complex. A number of dirt tracks are apparent across various parts of the project area and larger bituminised secondary roads form the western and southern margins of the project area.

Figures 2 and 4 indicates that the land surface underlying the entire extent of the township project area and the bulk sewer line is flat and featureless. The prominent hill Nelsonskop lies approximately 1 km to the north-west and rugged hills composed of rocks of the Waterberg Group lie approximately 12 km to the south. No significant fluvial drainage lines cross-cut the site of the proposed township extension, but a small and ephemeral channel is located immediately proximal to the eastern margin of the township project area. This fluvial drainage line lies immediately to the south the bulk sewer line. The channel flows to the east where it becomes a tributary of the Sandloop River. The Sandloop River drains the southern Waterberg Hill and flows to the north-east where it coalesces with the Mokolo River.

The entire extent of the project area is vegetated with mixed broadleaf/acacia forest of the Limpopo Sweet Bushveld veld type (Figure 5). Mucina and Rutherford (2006) indicate that the conservation status of both the Limpopo Sweet Bushveld type is categorised as least threatened. The central and eastern-most portions of the project area contain extensive areas of built structures and are presumably utilised for human habitation. The remainder of the project area is probably utilised for game farming, game conservation and/or cattle grazing.

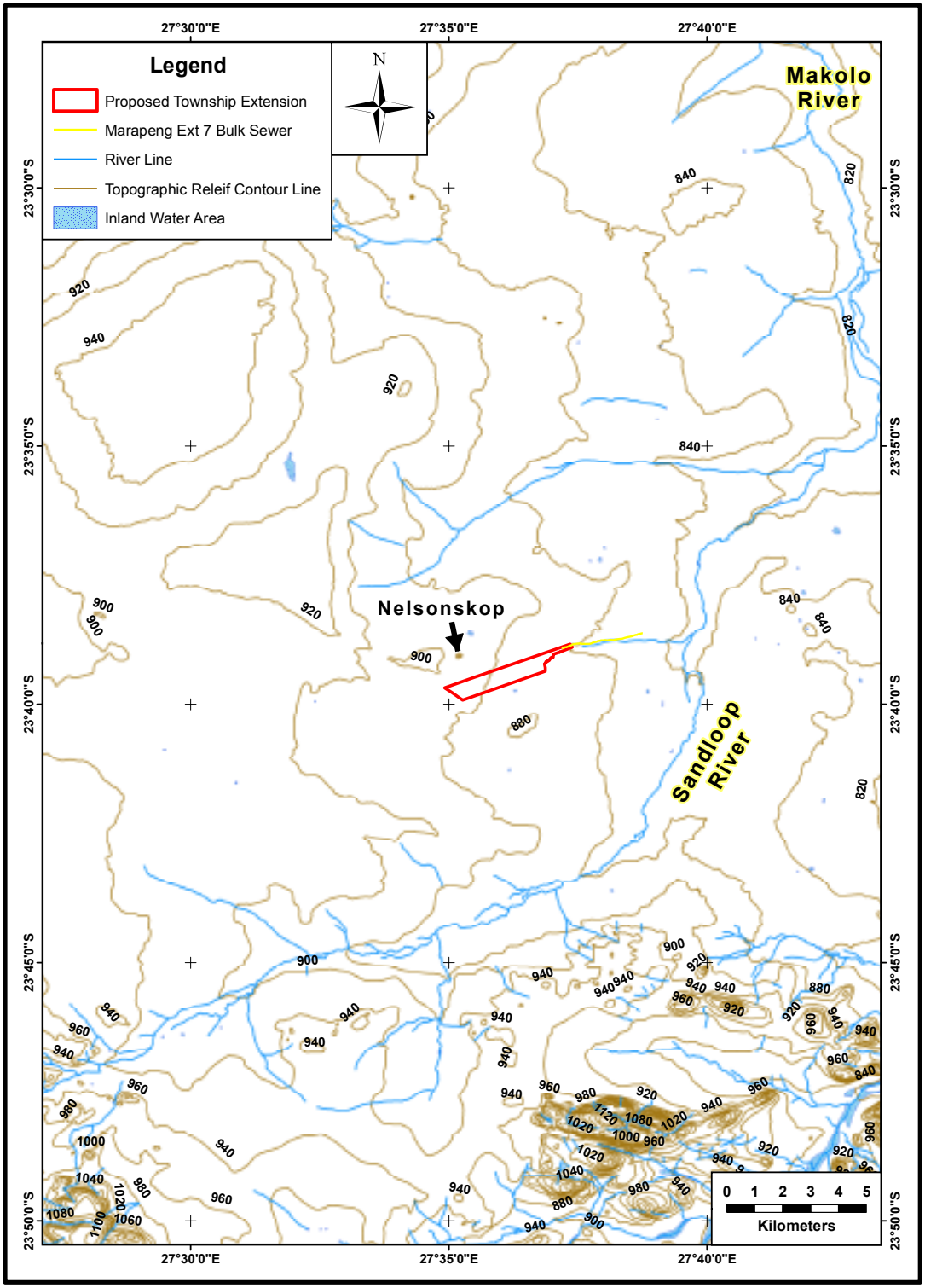

Figure 4: Map of the environment of the project area and its immediate environs. The topographic relief contour interval is 20 m. It is evident that the majority of the region is topographically flat and featureless. No significant fluvial drainage lines traverse the township extension area, but a tributary of the Sandloop River is located immediately proximal to the eastern margin of the project area and lies immediately to the south of the bulk sewer line.

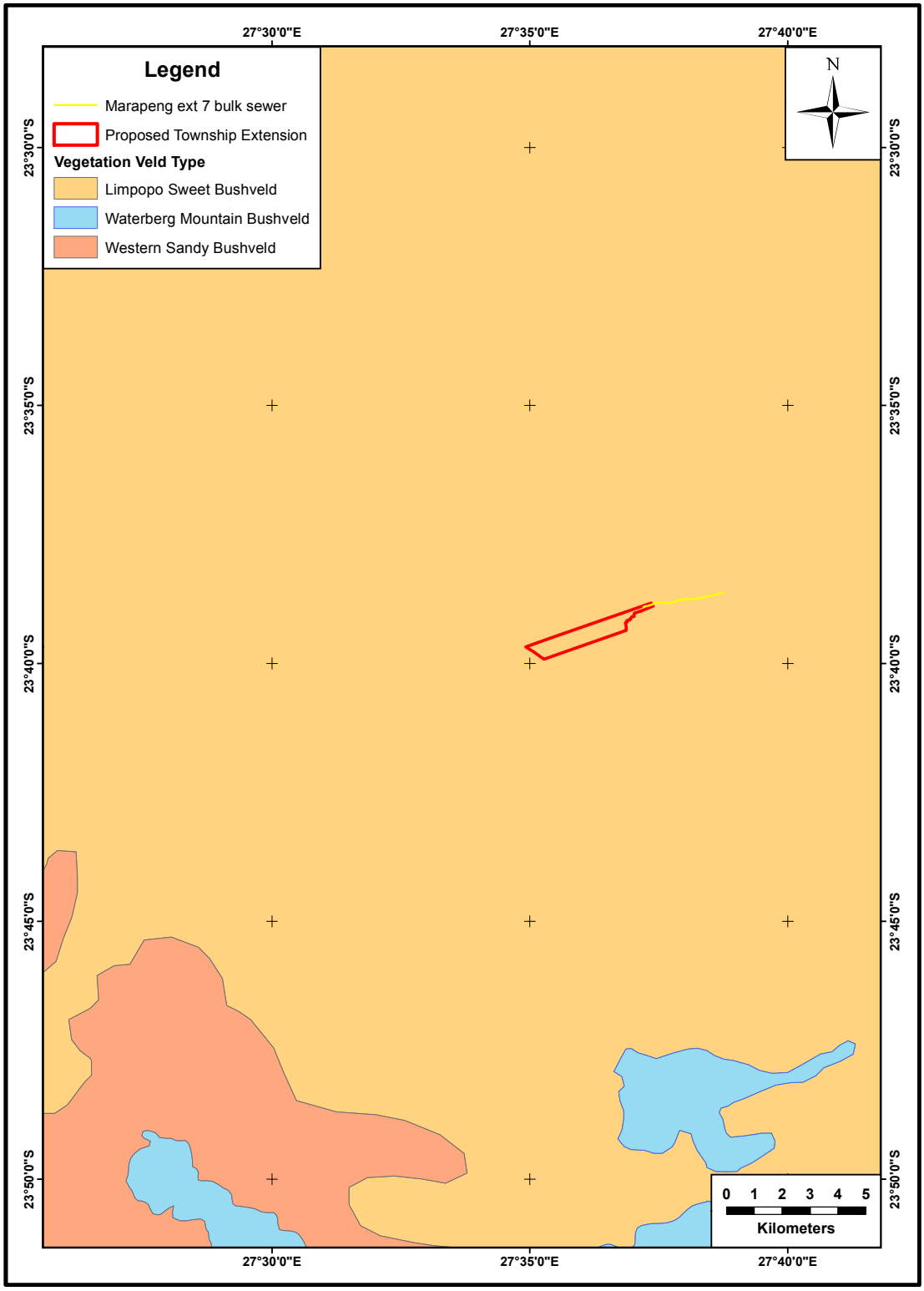

Figure 5: The distribution of the various vegetation veld types occurring beneath the proposed project area and its immediate environs. It is evident that the entire area to be underlain by the project infrastructure consists of the Limpopo Sweet Bushveld veld type (after Mucina and Rutherford, 2006).

8 OVERVIEW OF SCOPE OF THE PROJECT

The proposed township project will consist of an extension of the existing Maropong Township and a bulk sewer line. The total extent of the township project footprint is approximately 220 ha. The route of an approximately 2.8 km long bulk sewer line extends eastwards from within the township extension area. The sewer line extends approximately 2.4 km outside the township area. The exact footprint of the area that will be underlain by the bulk sewer pipeline is assumed to be less than 10 m wide. Accordingly, the aerial extent of the area that will potentially be impacted by the pipeline external to the demarcated township development is 24 000 m^2.

The township extension project has been subdivided into a number of areas (Figure 6) identified as Areas 1 (± 8.7 ha), 2 (± 66.4 ha), 3 (± 83.2 ha), 4 (± 60.4 ha), a coal conveyer belt area and an undetermined usage area. Area 1 is defined as an area that is affected by squatters and flooding, Area 2 is an area affected by a storm water dam (shown on Figure 6 as the undetermined area) and flooding, Area 3 is currently developed as a contractor's camp for ESKOM and also contains a coal conveyer belt. Area 4 is also currently partially developed as a contractor's camp. The proposed project will utilise Areas 1 and 2 as a low density residential township with stands of ±300 m average size, with road widths varying between 12-16 m and including parks, a pre-school, a cemetery and a police station. Areas 3 and 4 are to be zoned for high density residential usage in accordance with the needs and requirements of Exxaro.

The exact nature and scope of the anticipated infrastructural elements that will comprise the township extension project are unknown to the author at the time of compilation of this report. However, given the project outline in the preceding paragraph a number of assumptions are made that underpin the finding of this report concerning the effects of the proposed constructions upon the underlying geological units and these are summarised as follows. The infrastructure associated with the township will consist of various elements (e.g., buildings, roads, car parks, sewage and water mains and associated pipeline networks). It is anticipated, herein, that the depth of any excavations required to construct the various infrastructure elements will be limited to the uppermost 3 m of the land surface; this depth is slightly deeper than the depth of graves in the proposed cemetery. It is also anticipated that most, if not all, of the effects of the construction process with be restricted to the superficial, unconsolidated Cenozoic regolith. The anticipated life of the project is considered to be considered long term to permanent.

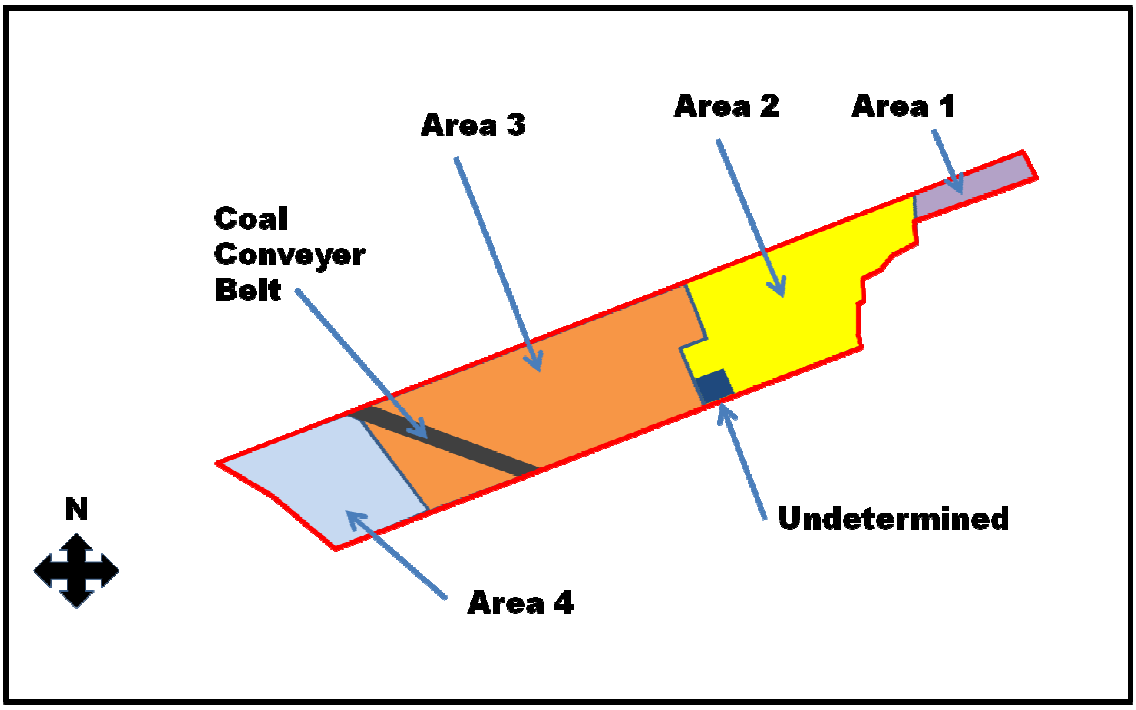

Figure 6: The location of the proposed township extension (red polygon) showing the position of the various present use subdivisions (Areas 1-4) as well as the coal conveyer belt and undetermined area that characterise the project area.

9 IMPACT ASSESSMENT

The potential impact of the proposed mining area is categorised below according to the following criteria:-

9.1 Nature of Impact

The potential negative impacts of the proposed project on the palaeontological heritage of the area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of the projects infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

9.2 Extent of impact

The possible extent of the permanent impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The possible source of a less permanent negative impact on the palaeontological heritage is the loss of access for scientific research to any fossil materials that become covered by the various infrastructural elements that comprise the project. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below any new infrastructural elements (e.g., buildings, roads, parks, power lines, bulk sewer line and the planned cemetery), but which are not uncovered during the necessary excavations, will be unavailable for scientific study for the life of the existence of those features.

9.4 Probability of impact

The rocks of the Karoo Supergroup are extremely poorly exposed within the project area and little meaningful investigation of their palaeontological potential will be possible as part of a site visit. It is known that units or their stratigraphic equivalents are fossiliferous elsewhere in southern Africa; as such there is a reasonable chance of fossil materials occurring within any Karoo rocks underlying the project area. However, it is pertinent to realise that fossils (particularly vertebrate fossils) are generally scarce and sporadic in their occurrence (but where fossil plants occur they are often found is dense accumulations). The probability of fossils within the Karoo strata being negatively impacted by the proposed developments is further lessened by the fact that the Karoo strata appear to be uniformly covered by Cenozoic sands that were interpreted (on the basis of the grasses present) to be at least 3.5 m thick in several locations. As the

majority of the infrastructure (including the bulk sewer line) to be constructed will probably only affect the upper few (3 m) of the land surface little impact on the Karoo rocks is anticipated over the majority of the project area. The probability of the construction of the new infrastructure elements associated with the township extension negatively impacting upon the palaeontological heritage of the Clarens Formation is accordingly assessed as **low.** The probability of the construction of the new infrastructure elements associated with the township extension and the associated bulk sewer line negatively impacting upon the palaeontological heritage of the Swartrant Formation is assessed as being **medium** due to the generally more abundant nature of plant macrofossils compared to vertebrate fossils.

The rocks of the Letaba Formation are not fossil-bearing. As such the probability of any negative impact on the palaeontological heritage of this unit is assessed as **nil**.

The author has conducted field work in the nearby region in the past. During that work no fossil materials were located within the Cenozoic regolith. The Cenozoic sediments within the local area are both coarse-grained and oxidised which also reduces the possibility of any organic materials having been preserved post deposition; however, the possibility remains that palaeontological materials may be present in subsurface horizons. The probability of any construction activities negatively impacting upon the palaeontological heritage of the Cenozoic regolith is accordingly assessed as **low**.

9.5 Significance of the impact

The palaeontological content of the Karoo Supergroup rocks of the Ellisras Basin is poorly know due to the very poor to usually non-existent outcrop, but scientifically and culturally significant fossil assemblages are known to occur within the rocks of the Karoo Supergroup elsewhere is Southern Africa. The Early Permian rocks of the Swartrant Formation contain coals and are correlative with the Ecca Group in the Main Karoo Basin. These rocks could reasonably be expected to contain significant plant macrofossil assemblages belonging to the *Glossopteris* flora as are known to occur in the lithologically similar and approximately time equivalent Vryheid Formation. Any new fossil materials occurring within this palaeontologically poorly know unit would potentially be of great scientific significance.

The Clarens Formation is not richly fossiliferous anywhere in southern Africa, but does contain a range of early dinosaur taxa, some of the earliest mammals and vertebrate trackways amongst other fossil types. Plant macrofossils are very sparingly present, but are know. Any fossil material present within the Clarens Formation rocks underlying the project area would potentially be both highly scientifically and culturally significant.

The rocks of the Letaba Formation consist of extrusive pictritic lavas. No fossil materials are expected to be present within these rocks and, as such, the palaeontological heritage significance of any development upon these rocks would be nil.

Any palaeontological materials that may have been incorporated into the Cenozoic sandy regolith would potentially provide scientifically important data concerning the paleoenvironment and palaeoclimate of the region. Fossil deposits of Cenozoic age are not common within the geological record of the wider region; thus, the rarity of fossils within the sequence makes each fossil that may be present, **potentially highly scientifically significant**.

The scientific and cultural significance of fossil materials is underscored by the fact that many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

The certainty of the exact *in situ* location of fossils and their precise location within the stratigraphic sequence is essential to the scientific value of fossils. The movement of any fossil material during the construction of the facility that results in the exact original location of the fossil becoming unknown will either greatly diminish or destroy the scientific value of the fossil.

Thus, the probability of a negative impact on the palaeontological heritage contained within the Swartrant Formation is categorised as medium and as low in the Clarens Formation). Similarly, the probability of a negative impact on the palaeontological heritage contained within the Cenozoic regolith underlying the project area is categorised as low, the significance of any negative impact posed by the project on the palaeontological heritage is categorised as potentially high if appropriate mitigation procedures are not put into place.

9.6 Severity / Benefit scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide accommodation to low income members of the public. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as **low** in areas underlain by rocks of the Clarens Formation as well as within the Cenozoic regolith, but **medium** in the rocks of the Swartrant Formation. The probability of any negative

impact upon the palaeontological heritage of the area posed by any development that impacts the Letaba Formation has been assessed as being **nil**.

The low to medium likelihood of fossils being directly affected by portions of the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa (particularly vertebrate forms) are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that elsewhere in the region the rocks of the Karoo Supergroup contain extremely significant fossils for documenting the transition from reptiles to mammals as well as the early evolution of dinosaurs. Scientifically significant plant macrofossil assemblages are also found throughout the Karoo Supergroup sequence. Cenozoic regolith sequences within South Africa occasionally contain fossils that provide a rare insight into the palaeoecology and palaeoclimate of the period. Thus, it is possible that there are fossils of the highest scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South. **Thus, while the likely hood of any disturbance of palaeontological materials is medium in the Swartrant Formation and low in both the Clarens Formation and Cenozoic deposits, the severity of any impact is potentially extremely high**. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation procedures. **If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category**.

A potential secondary benefit of the project would be that the excavations resulting from the progress of the project may uncover fossils materials that were hidden beneath the surface regolith exposures and, as such, would have remained unknown to science. If the planned excavations are inspected, while they are occurring, with a view to identifying any possible palaeontological materials present the possibility would be generated of being able to study and excavate fossil materials that would otherwise be hidden to scientific study.

9.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced during the conduct of those construction activities located upon the Swartrant and Clarens Formations and the Cenozoic regolith any negative effect on the palaeontological heritage of the area will be minimised to the extent possible. As the proposed project would provide accommodation to low income people project is determined as having a **positive status** herein.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed or will result in irreversible loss of the palaeontological heritage can be determined as discussed below.

10.1 Mitigation

It is recommended that:

- An appropriate staff member (e.g., the environmental officer) of the company responsible for the construction process be trained in recognition of the types of fossils that may be expected to be encountered in the envisioned excavations.
- The relevant employee should make regular and thorough examinations of all excavations that occur within the sediments of the Karoo Supergroup and Cenozoic regolith.
- Should any fossil materials be identified, the excavations in that area should be halted in that location and SAHRA informed of the discovery (see Section 3.4 above).
- A palaeontologist must then be appointed by the company to evaluate the fossil deposits and make the necessary recommendations regarding damage mitigation of the fossils materials.
- The excavations associated with the project should be inspected by a palaeontologist 2 times a year (i.e., once every 6 months) while they are occurring to ensure that no fossil materials are being damaged or destroyed.

A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality should be protected and the fossil site excluded from any further mining.

10.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials or reduction of scientific value due to a loss of the original location is **irreversible**.

10.3 Degree of irreversible loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible**.

Fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material that may be contained within the strata underlying the project area is potentially of the greatest scientific and cultural importance. Thus, the potential always exists during the conduct of the construction of the project within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a desktop study of available maps, the available scientific literature and the author's knowledge based on previous studies within nearby region. The exact activities required to undertake this project and complete details of any infrastructure that may be required were not available to the author at the time of preparation of this report. In order to assess the potential impacts of the project upon the palaeontological heritage of the area assumptions were made concerning both the necessary activities and infrastructure by comparison to normal practice in other comparable exploration and mining projects in South Africa. The geological occurrence of fossils within fossiliferous geological units is sporadic and cannot be interpreted with precision or certainty.

12 ENVIRONMENTAL IMPACT STATEMENT

It is desired to construct an extension of the existing Morapong township and a bulk sewer pipeline on a site near Lephalale in the Limpopo Province. The proposed township development is located approximately 12 km west of Lephalale on Portion 1 and the Remaining Extent of the farm Nelsonskop 464 LQ, Magisterial District of Lephalale. The

aerial extent of the proposed project is approximately 220 Ha and will consist of a mix of low and high density housing as well as other community needs (e.g. a cemetery, police station and parks). The route of an approximately 2.8 km long bulk sewer line extends eastwards from within the township extension area. The sewer line extends approximately 2.4 km outside the township area. The exact footprint of the area that will be underlain by the pipeline is assumed to be less than 10 m wide. Accordingly, the aerial extent of the area that will potentially be impacted by the pipeline external to the demarcated township development is 24 000 m^2. Any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the construction activities and, as such, the extent of any impact is accordingly characterised as local.

The construction of the proposed township extension will primarily affect the Cenozoic regolith, with a reduced possibility of any effects occurring to the strata of the Karoo-age Swartrant and Clarens Formations. This assumption is based on the expectation that the planned infrastructure is expected to have relatively shallow impacts (i.e., < 3 m) and should mostly affect the Cenozoic regolith due to its extensive and thick occurrence throughout the region. Where the construction activities impact directly upon the Cenozoic regolith or and Clarens Formations the probability of any negative impact upon the palaeontological heritage of these units is assessed as low. In those locations where the Swartrant Formation will be impacted the probability of any negative impact upon the palaeontological heritage is assessed as being medium. The rocks of the Letaba Formations are unfossiliferous and, as such, any disruption of these units will result in nil possibility of any negative impact upon their palaeontological heritage.

Despite the characterisation of the risk of a negative impact resulting upon the palaeontological heritage of the either the Cenozoic regolith or Clarens Formation being assessed as low and that of the Swartrant Formation being assessed as medium any fossil materials that they may contain will potentially be of high scientific and cultural importance. This study has identified that the underlying strata of the Karoo Supergroup and the Cenozoic cover sequences are fossiliferous elsewhere in South Africa. As such, fossils are potentially present beneath the planned construction projects (particularly in the Karoo Supergroup which is completely covered by the regolith and, as such, could not be directly investigated). Any damage, destruction or inadvertent movement of these fossils will result in permanent and irreversible damage. Similarly, any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations associated with the constructions will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes. It recommended that:

- An appropriate staff member (e.g., the environmental officer) of the company responsible for the construction process be trained in recognition of the types of fossils that may be expected to be encountered in the envisioned excavations.
- The relevant employee should make regular and thorough examinations of all excavations that occur within the sediments of the Karoo Supergroup and Cenozoic regolith.
- Should any fossil materials be identified, the excavations in that area should be halted in that location and SAHRA informed of the discovery (see Section 3.4 above).
- A palaeontologist must then be appointed by the company to evaluate the fossil deposits and make the necessary recommendations regarding damage mitigation of the fossils materials.
- The excavations associated with the project should be inspected by a palaeontologist 2 times a year (i.e., once every 6 months) while they are occurring to ensure that no fossil materials are being damaged or destroyed.

The social benefits of the project have been classified as beneficial, herein, as the project aims to provide low cost housing and a community to low-income people. As such, **this study has not identified any palaeontological reason to prejudice the construction of either the Marapong Township extension project or the bulk sewer pipeline, subject to adequate mitigation programs being put in place**.

13 REFERENCES

Bamford, M.K. (2004). Diversity of woody vegetation of Gondwanan southern Africa. *Gondwana Research*, 7: 153-164.

Barker, 0.B., Brandle, G., Callaghan, C.C., Eriksson, P.G. and van der Neut, M. (2006). The Soutpansberg and Waterberg Groups and the Blouberg Formation. In Johnson, M.R. Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 301-318.

Duncan, A.R. and Marsh, J.S. (2006). The Karoo Igneous Province. In Johnson, M.R. Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 501–520.

Geological Survey of South Africa (1993). 1:250 000 Geological Series Sheet 2326 Ellisras.

Haughton, S.H. (1924). The fauna and stratigraphy of the Stormberg beds of South Africa. Annals of the South African Museum, 12: 323-497.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., de V. Wickens, H., Christie, A.D.M., Roberts, D.I., and Brandl, G. (2006). Sedimentary Rocks of the Karoo Supergroup, In Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) *The Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 461–499.

Kitching, J.W., and Raath, M.A. 1984. Fossils from the Elliot and Clarens Formations (Karoo Sequence) of the northeastern Cape, Orange Free State and Lesotho, and a suggested biozonation based on Tetrapods. *Palaeontologia Africana*, 25:111-125.

Mucina, L. and Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelizia* 19. South African National Biodiversity Institute, Pretoria.

Olsen, P.E., and Galton, P.M. 1984. A review of the reptile and amphibian assemblages from the Stormberg Group of southern Africa with special emphasis on the footprints and the age of the Stormberg. *Palaeontologia Africana*, 25: 87-110.

Republic of South Africa (1998). National Environmental Management Act (No 107 of 1998). Pretoria: The Government Printer.

Republic of South Africa (1999). National Heritage Resources Act (No 25 of 1999). Pretoria: the Government Printer.

Raath, M.A. (1969). A new coelurosaur dinosaur from the Forrest Sandstone of Rhodesia. *Arnoldia*, 4: 1-25.

Rubidge, B.S., Johnson, M.R., Kitching, J.W., Smith, R.M.H., Keyser, A.W. and Groenewald, G.H. (1995). *An introduction to the biozonation of the Beaufort Group*, In Rubidge, B.S., (ed) biostratigraphy of the Beaufort Group (Karoo Supergroup). Biostrat Series South Africa Committee for Statratigraphy., 1, 1-2.

South African Committee for Stratigraphy (SACS) (1980) Stratigraphy of South Africa. Part 1 (Comp. L.E. Kent). Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda, Hand Book of the Geological Survey of South Africa 8.

Van Dijk, D.E., Hobday, D.K. and Tankard. (1978). Permo-Triassic lacustrine deposits of the eastern Karoo Basin, Natal, South Africa. In Matter, A. and Tucker, M.E. (eds) *Modern and anchient lake sediments*, International Association of Sedimentologists Special Publication 2, pp. 229-235.

Weishampel, D.B.; Dodson, P; and Osmólska, H. (eds.) (1990): *The Dinosauria*, Berkeley: University of California Press. 880 pp.

Dr B.D. Millsteed

11th July 2017