DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF THE PROPOSED GROOTHOEK REGIONAL WATER SCHEME LEBOWAKGOMO BULK WATER SUPPLY PIPELINE SCHEME TO BE LOCATED WITHIN THE TOWN OF LEBOWAKGOMO, LIMPOPO PROVINCE

2 July 2017

Prepared for:

Heritage Contracts and Archaeological Consulting CC

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Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

The Capricorn District Municipality proposes to construct a water supply pipeline for supply of water to the town of Lekowakgomo. The project area is situated 48 km South of Polokwane within the town of Lebowakgomo. Access to the area is from the R37 and R518 roads and internal connector roads. Nearest large town to the development area is Polokwane (48 km to the North). The major portion of the proposed pipeline scheme extends for approximately 23.3 km in an east-west direction. A shorter north-south oriented arm northwards approximately 2.1 km from the western margin of Chuniespoort to join up with the project. A ca. 1 km north-south oriented arm is located along the western bank of the Hlkaro River. A ca. 300 m long northwest-southeast oriented spur extends north of the main pipeline. A ca. 300 m long "L shaped" spur located west of Mamaolo extends southwards from the main pipeline. A ca. 280 m long segment located immediately north of Mamaolo (extending north-westerly from the top of a rounded hill).

Tekplan Environmental appointed Heritage Contract and Archaeological Consulting CC has to compile a Heritage Impact Assessment Report in respect of the project. Heritage Contract and Archaeological Consulting CC has contracted BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report for the project.

The majority of the project area is underlain by rocks of the late Achaean to early Proterozoic rocks of the Transvaal Supergroup. These units consist of the Chuniespoort Group (Malmani Subgroup and Duitschland Formation) and undifferentiated rocks of the Pretoria Group. Late Triasic/Early Jurassic sediments of the Clarens Formation (Karoo Supergroup) underlie the western-most extent of the project's infrastructure. The rocks of the Clarens Formation are known to be fossiliferous and to contain highly scientifically significant fossil assemblages. The probability of the project negatively impacting upon the fossil assemblages of the Clarens formation is low. The carbonate sediments of the Malmani Subgroup are richly fossiliferous containing abundant assemblages of stromatolites and the probability of the project impacting upon these is high; however, the significance of any such impact will be low. The Duitschland Formation and the rocks of the Pretoria group are unfossiliferous; the probability and significance of the palaeontological heritage of these units being negatively impacted is nil.

No damage mitigation protocols are required to preserve the palaeontological heritage of the project area in those portions of the project that are underlain by the rocks of the Malmani Subgroup, Duitschland Formation or the Pretoria Group and none are suggested herein.

The Clarens Formation contains scientifically important fossils that may be negatively impacted upon by the project. As such, any excavations that are produced within the portion of the project area underlain by the Clarens Formation, for the emplacement of the pipelines, may well expose scientifically valuable fossils. It is recommended, therefore, that all excavations that are produce into the Clarens Formation land surface within Mmaphelo Township should be inspected by a qualified palaeontologist before the pipes are laid and the trenches infilled with soil. Should any fossil materials be identified the excavations in that area should be halted in that location and SAHRA informed of the discovery. 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 construction and the location of the pipeline moved.

This desktop study has not identified any palaeontological reason to prejudice the construction of the water supply pipeline project subject to the proposed damage mitigation procedures being implemented.

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

The Capricorn District Municipality proposes to construct a water supply pipeline for supply of water to the town of Lekowakgomo. The project area is situated 48 km South of Polokwane within the town of Lebowakgomo. Access to the area is from the R37 and R518 roads and internal connector roads. Nearest large town to the development area is Polokwane (48 km to the North). Figure 1 shows the location of the pipeline project. The major portion of the proposed pipeline scheme extends for approximately 23.3 km in an east-west direction. A shorter north-south oriented arm northwards approximately 2.1 km from the western margin of Chuniespoort to join up with the project. A ca. 1 km north-south oriented arm is located along the western bank of the Hlkaro River. A ca. 300 m long northwest-southeast oriented spur extends north of the main pipeline. A ca. 300 m long "L shaped" spur located west of Mamaolo extends southwards from the main pipeline. A ca. 280 m long segment located immediately north of Mamaolo (extending north-westerly from the top of a rounded hill).

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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.

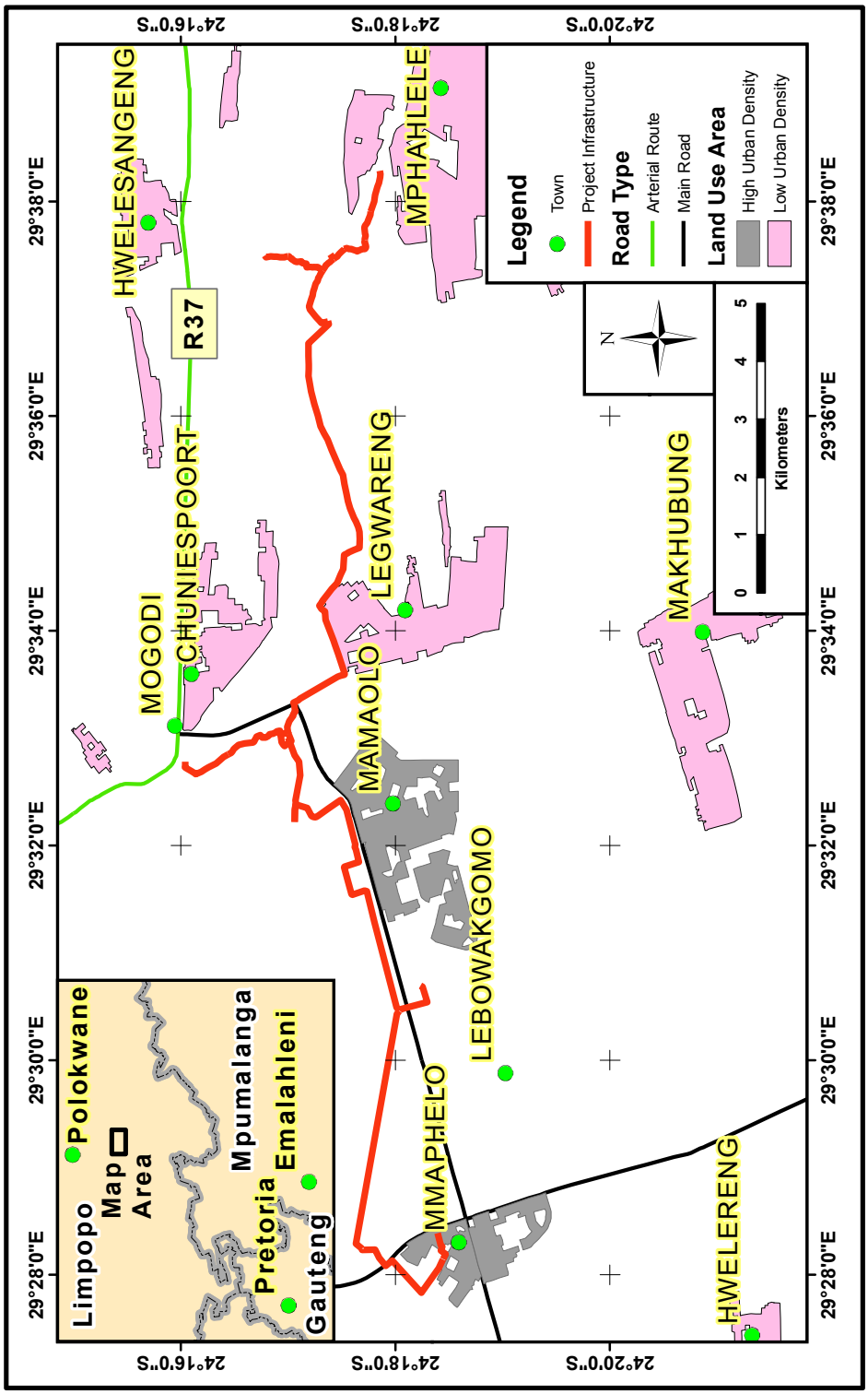

Figure 1: Location map showing the position of the proposed water supply pipeline project.

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 of the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest either in the construction of the water supply pipeline and its associated infrastructure nor any companies or individuals associated with the project.

6 GEOLOGY AND FOSSIL POTENTIAL

Figure 2 shows that the majority project area is completely underlain by rocks of the late Archaean to early Proterozoic rocks of the Transvaal Supergroup. These units consist of the Chuniespoort Group (Malmani Subgroup and Duitschland Formation) and undifferentiated rocks of the Pretoria Group. The western-most extent of the project infrastructure is underlain by Late Triasic/Early Jurassic sediments of the Clarens Formation (Karoo Supergroup).

6.1 Transvaal Supergroup

6.1.1 Malmani Subgroup

6.1.1.1 Geology

The up to 2000 m thick Malmani Subgroup of the Transvaal Basin consists of five formations. Listed in order of decreasing stratigraphic age these formations are the Oaktree, Monte Christo, Lyttelton, Eccles and Frisco Formations. A tuff layer in the Oaktree formation has been dated as being late Archaean (2585 Ma; Martin *et al*., 1998)

The five formations are differentiated on the basis of chert content, stromatolite morphology, morphology of intercalated shales (Erikssson, 2006). The Malmani Formation carbonates reflect three major transgressive-regressive macrocycles, upon

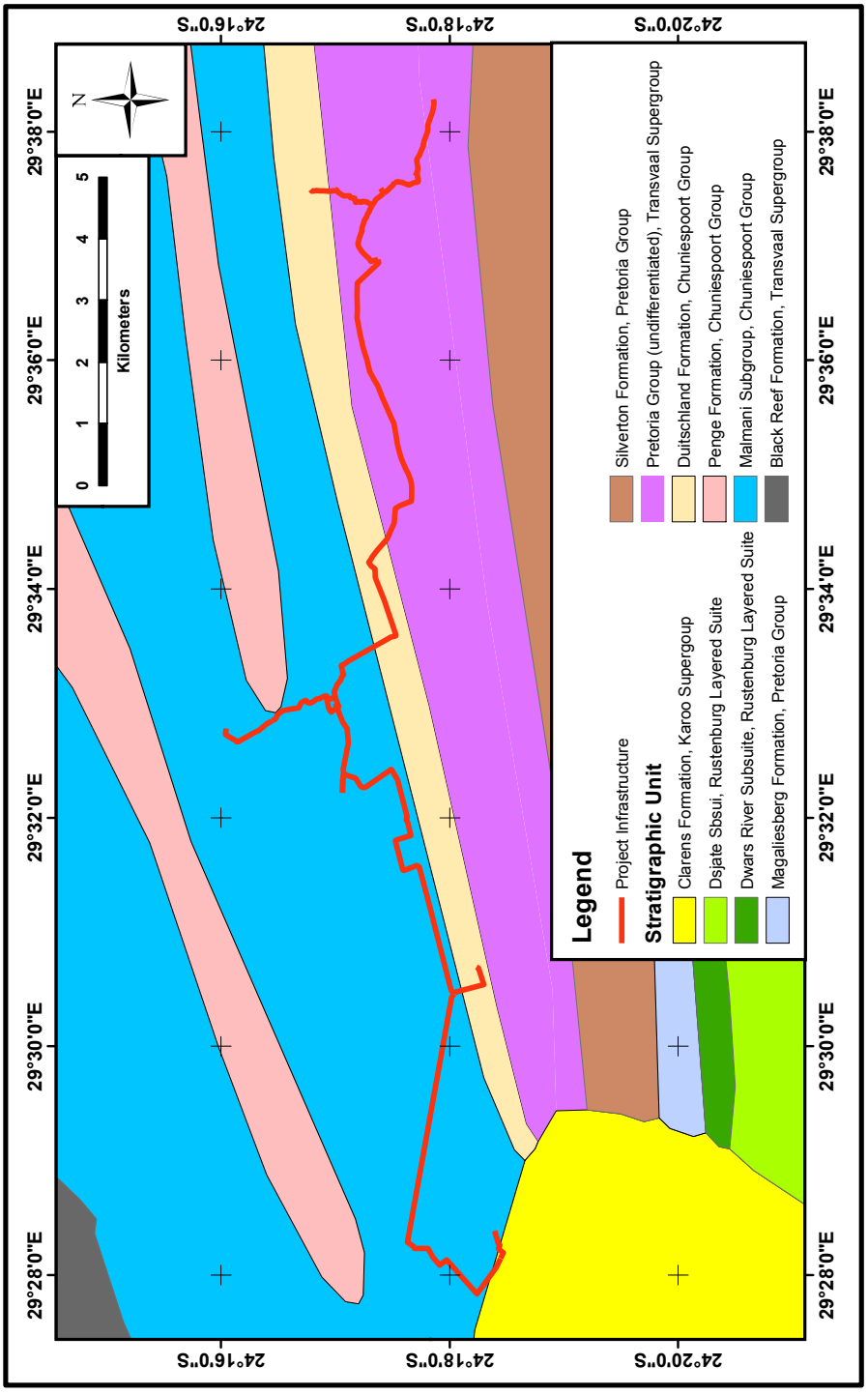

Figure 2: Geological map of the area underlying the path of the proposed water supply pipeline and its immediate environs.

which are superimposed a number of subordinate cycles. Each macrocycle commences with a chert breccia at the base of a thin carbonaceous shale and is capped by a thick succession of carbonates. The chert-breccia residues mark important regressive phases when the carbonates were subjected to intense chemical weathering and are believed to mark regional disconformities. It is clear that the fundamental subdivisions of the Malmani Subgroup are based on the recognition of two main facies. The first is a pale grey, chert-rich dolomite and the second Is dark grey to black, chert poor, fine-grained dolomites and limestones, often in association with higher than normal amounts of clastic sediment.

6.1.1.2 Palaeontological potential

The carbonates of the Malmani Subgroup are well known for being richly stromatolitic with a number of different morphologies present. Eriksson and Truswell (1974) and Eriksson *et al*., (1975) proposed a tidal paleoenvironmental model for the deposition of the unit, with deposition ranging between supratidal flat stromatolitic mats to intertidal columnar stromatolites. No other fossil types are known to occur within the unit.

6.1.2 Duitschland Formation

6.1.2.1 Geology

The early Proterozoic Duitschland Formation consists of up to 700 m of carbonaceous mudrocks, limestones and dolomites with subordinate conglomerates, diamictites and lavas. Clendenin (1989) has interpreted this unit as having been deposited in the final, shallow marine, regressive facies of the Malmani-Penge epeiric sea.

6.1.2.2 Palaeontological Potential

No fossil materials are known to occur within the carbonate rocks of the Duitschland Formation. However, various carbonate lithogies within the stratigraphically underlying Malmani Subgroup are richly stromatolitic. The presence of stromatolites within the Duitschland Formation cannot be precluded.

6.1.3 Undifferentiated Pretoria Group

6.1.4 Geology

The Pretoria Group consists of an approximately 6-7 km thick succession comprised mainly of mudrocks alternating with quartzitic sandstones, significant interbedded basaltic–andesitic lavas and subordinate conglomerates, diamictites, and carbonate rocks (Eriksson *et al*., 2006). The identity and lithology of the rocks present within this

geological succession of the project area is not known in detail. However, the strata occur between the underlying carbonates of the Duitschland Formation (which crops out to the immediate north) and the overlying sandstones of the Silverton Formation. Accordingly, the lithological sequence may well possibly contain any of the rocks of the Rooihoogte, Timeball Hill, Boshoek, Hekpoort, Dwaalheuwel, Strubenkop Formations and Daaspoort Formations. Thus, the sequence may consist of any of an alternating sequence of sandstones and mudstones (save for the additional possibility of diamictites in the Boshoek Formation) and the andesites of the Hekpoort Formation (Eriksson *et al.*, 2006).

6.1.5 Palaeontological potential

No palaeontological materials are known to occur in any of the possible strata that may constitute this geological sequence anywhere within their aerial extent. Accordingly, the palaeontological potential of this lithological sequence is assessed as being nil.

6.2 Karoo Supergroup

6.2.1 Clarens Formation

6.2.1.1 Geology

The Late Triassic/Early Jurassic Clarens Formation crops out at, and underlies, the extreme western end of the proposed location of the project infrastructure (Figure 2). The unit 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.

6.2.1.2 Palaeontological potential

Significant fossils assemblages, but less diverse than those identified within the 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.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The Capricorn District Municipality proposes to construct a water supply pipeline for supply of water to the town of Lekowakgomo. The project collectively covers a large area. The major portion of the proposed pipeline scheme extends for approximately 23.3 km in an east-west direction. A shorter north-south oriented arm northwards approximately 2.1 km from the western margin of Chuniespoort to join up with the project. A ca. 1 km north-south oriented arm is located along the western bank of the Hlkaro River. A ca. 300 m long northwest-southeast oriented spur extends north of the main pipeline. A ca. 300 m long "L shaped" spur located west of Mamaolo extends southwards from the main pipeline. A ca. 280 m long segment located immediately north of Mamaolo (extending north-westerly from the top of a rounded hill). The width of the area to be affected by the pipeline project is unknown to the author, but is assumed herein to be less than 10 m (including any associated servitude road). A total of 296 290 m^2 of bed rock will be affected.

Figures 3 and 4 show that the proposed location of the water supply pipeline project extends east-west between Mmaphelo and Mphahlele. The area is heavily populated with other towns located within the immediate environs of the project being Chuniespoort, Mogodi and Hwelesangeng to the north and Mamaolo, Lebowakgomo and Legwareng to the south. The project area lies at the southern foot of a prominent east-west oriented ridge and the land surface slopes gently from the ridge to the pipeline location. Similarly, the land surface south of the pipeline slopes gently towards the south-east from the town of Mmaphelo towards Makhubung.

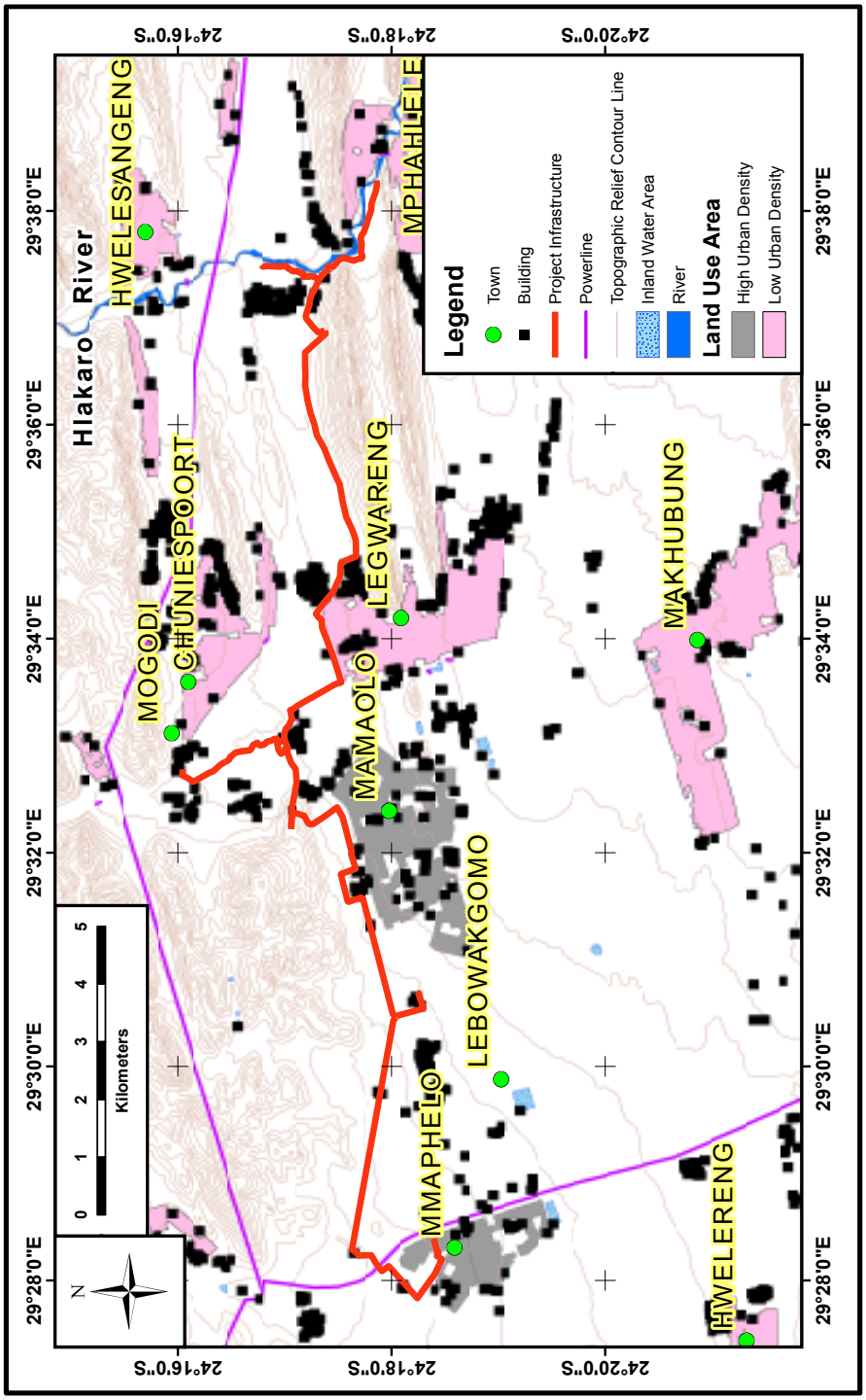

Figure 3: Map of the project area and its immediate environs. The topographic contour interval is 20 m.

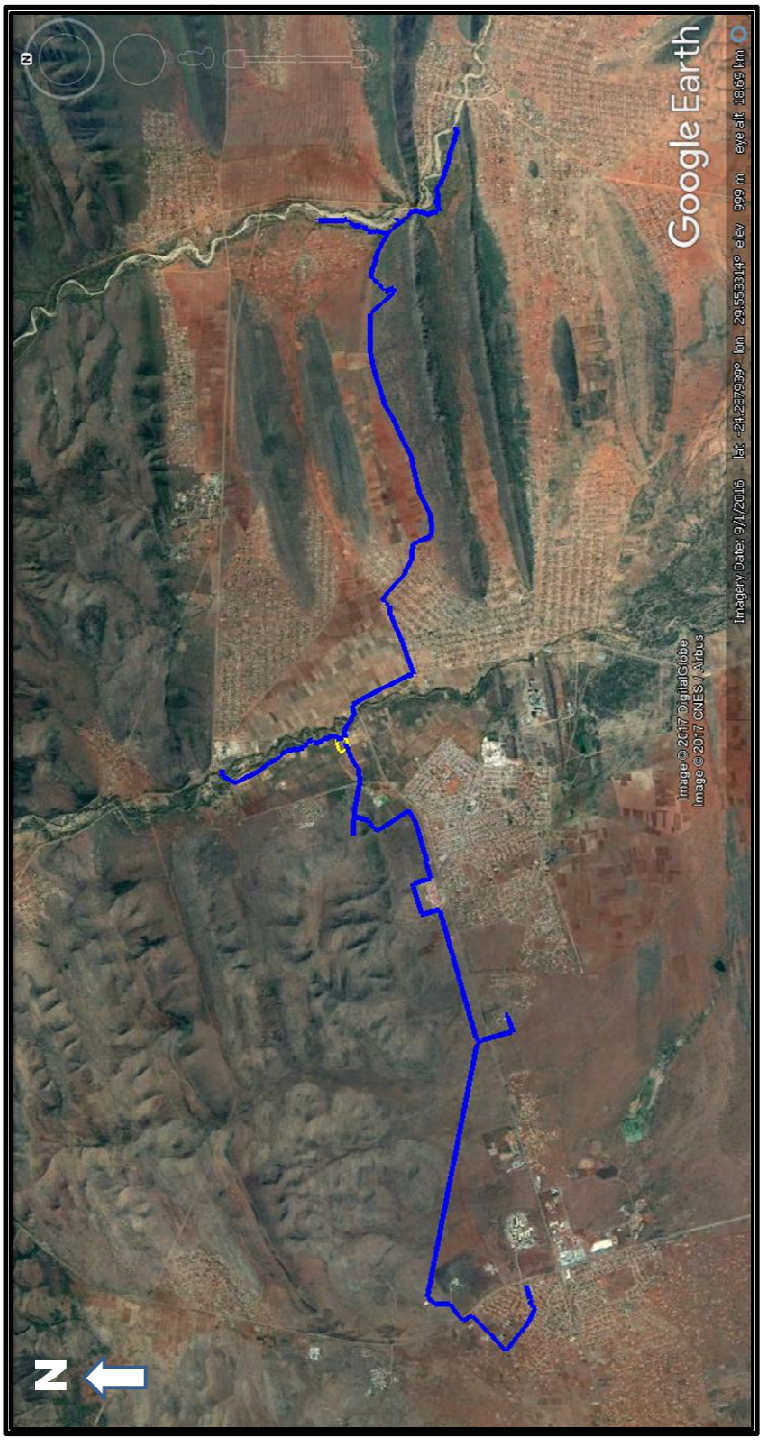

Figure 4: Google earth image of the area underlying the pipeline project and its immediate environs. The route of the proposed pipeline is shown with the blue line.

The Hlakaro River runs immediately adjacent, and parallel, to the eastern-most margin of the project.

The majority of the area underlying the path of the pipeline and its surrounding environs is underlain by two vegetation types; these being the Poung Dolomite Mountain Bushveld and the Sekhukhune Plains Bushveld (Figure 5); a small area comprising the western-most portion of the pipeline project is underlain by the Springbokvlakte Thornveld (Mucina and Rutherford, 2006). Mucina and Rutherford (2006) describe the conservation status of the Poung Dolomite Mountain Bushveld as least vulnerable, that of the Sekhukhune Plains Bushveld as vulnerable and the status of the Springbokvlakte Thornveld as endangered. It is evident from Figure 6 that the area originally vegetated with Springbokvlakte Thornveld is now located beneath Mmaphelo; it appears that the original vegetation is now non-existent in that area. East of Mamaolo most of the project area is underlain by urban development or cultivated agricultural land. The area west of Mamaolo and extending to Mmaphelo appears to vegetated with undisturbed, native vegetation.

8 OVERVIEW OF SCOPE OF THE PROJECT

8.1 Rationale for project

- It has previously been determined that the actual average daily supply from Lepelle Northern Water to the Lepelle Nkumpi is 12.42 ML/day with the current water demand for the Lepelle Nkumpi Municipal Area as 15.568 ML/day. This results in a shortfall of 3.148 ML/day.
- Water supply to Lebowakgomo (8 143 stands) and specifically Zone A (2 395 stands) and Zone B (1 147 stands) is erratic and serious pressure/supply problems are experienced in the high lying areas.
- Due to the fact that the bulk water supply system, the Olifants Sand Transfer Scheme (OSTS), was designed and installed more than fifteen years ago, the bulk supply system cannot supply the current demand with a growing population and new stands being developed in Lebowakgomo.
- Due to the water demand exceeding the supply, a supplement source for the Lebowakgomo area should be developed, which will in turn take pressure of the existing OSTS, making additional water supply available to the other water supply schemes within the Lepelle-Nkumpi Municipal area.
- The town of Lebowakgomo's storage forms part of the 25 ML Stocks reservoir and does not have a dedicated storage facility. A dedicated storage facility needs to be supplied for the town.

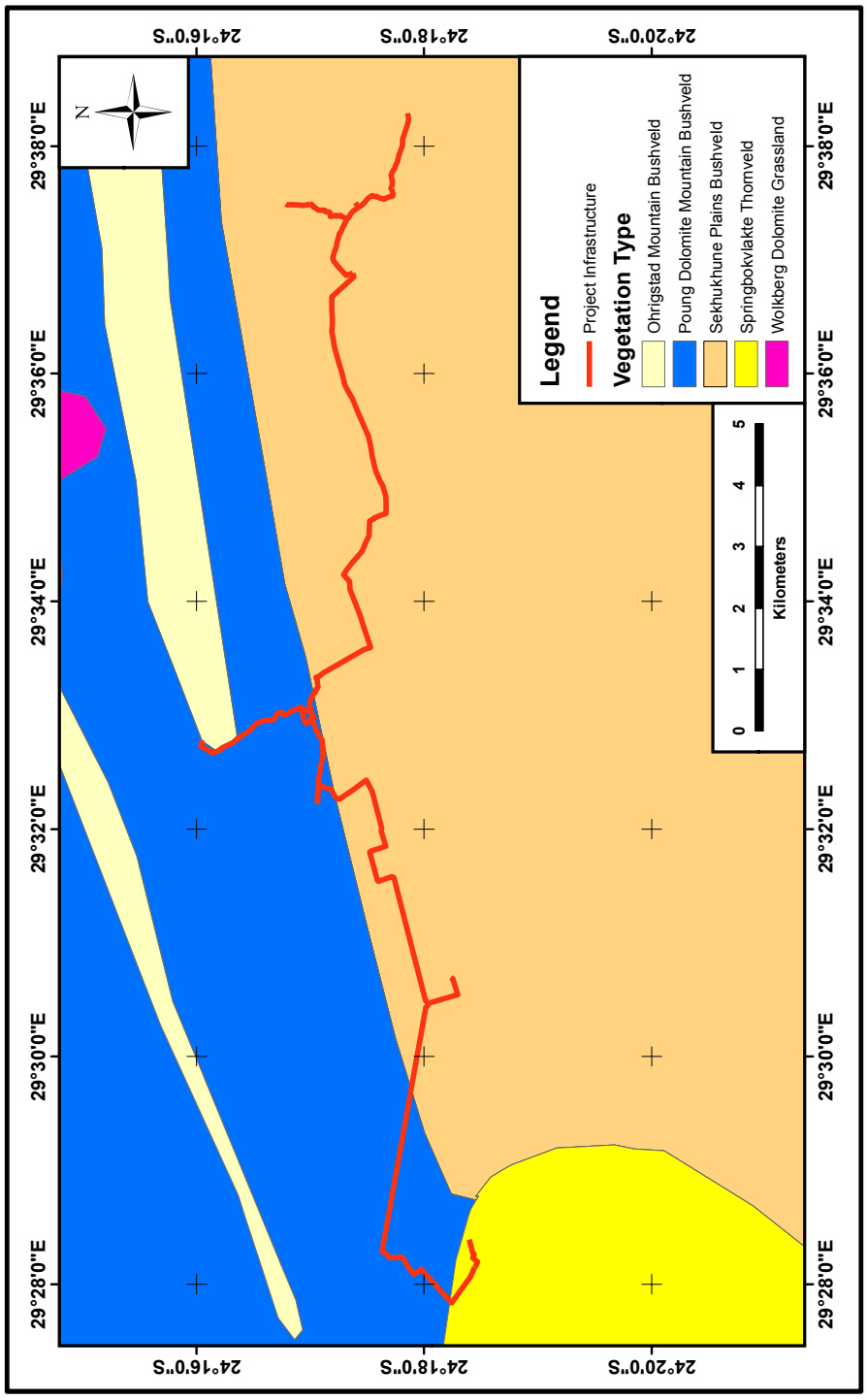

Figure 5: Map of the distribution of the vegetation veld types located beneath the project area and within its immediate environs (after Mucina and Rutherford, 2006).

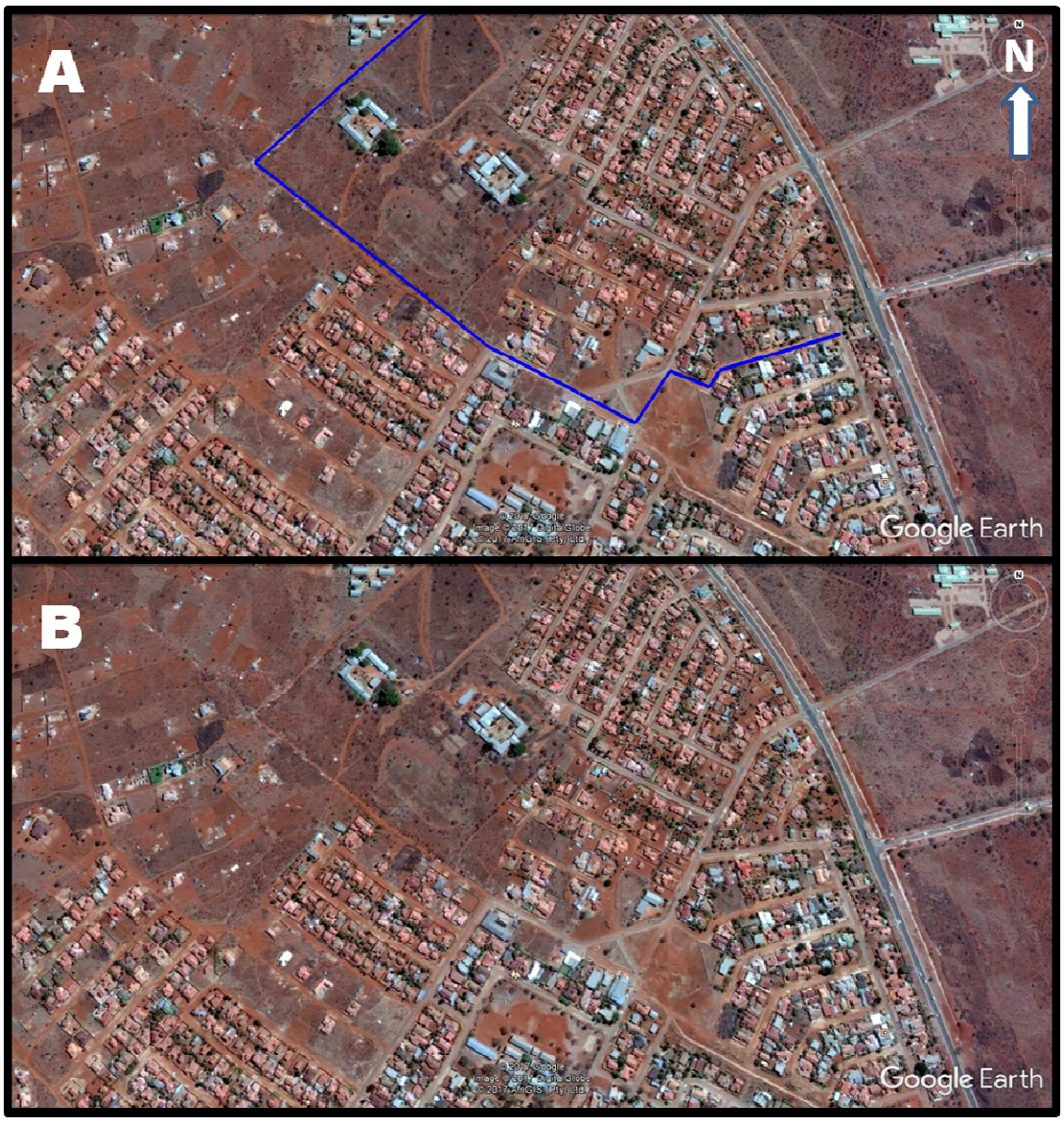

Figure 6: Google earth images of the area underlying the western-most portion of the Project and Mmaphelo. A) The blue line shows the route of the proposed pipeline; B) The same view as in Figure 6(A), with the route of the pipeline omitted. It is evident that the pipeline's route is co-incident with existing roads.

8.1.1 Bulk Supply Lines

The bulk supply lines consist of asbestos and uPVC pipelines in general good condition. The bulk supply system is operated and maintained by Lepelle Northern Water.

8.1.2 Storage Facilities

The regional storage facilities, Stocks and Specon reservoirs, are in good condition and has been placed such to supply sufficient pressure to the water supply system. The reservoirs are operated and maintained by Lepelle Northern Water. No dedicated storage facility for Lebowakgomo however exists.

8.1.3 Water Reticulation

The water reticulation system for Lebowakgomo mainly consists of asbestos and uPVC pipes installed with the establishment of the town. Over time the pipes, especially the asbestos pipes in Zone A, deteriorated such that extensive leaks occurred and that water was lost.

Water supply in Zone B is erratic with serious pressure problems being experienced in the higher lying areas. During the on-site investigations it was found that the supply lines feeding the reticulation system do not have the capacity to distribute the demand efficiently through the centralised reticulation system. In order to relieve to current problems experienced, reticulation pipes with the required capacity must be installed and connected to the existing reticulation system.

8.2 Scope of the project

The scope of work and the type and number of infrastructure elements required to be put in place to construct the project are:

- Equipping of boreholes (Pumps, motors & ancillaries) - 8 No.
- Refurbishment of existing borehole (H01-3278) - 1 No.
- Electrification of boreholes (Switch gear & power supply) - 9 No.
- Boreholes pump station buildings - 9 No.
- Raw water 4.5ML Concrete reservoir storage facilities - 2 No.
- Clean water 4.5ML Concrete reservoir storage facilities - 1 No.
- Inlet and outlet pipework at reservoirs - 2 No.
- UV Treatment and water softening package plant - 1 No.
- High lift pump station - 1 No.
- Pipe bridges for crossing the Tudumo River - 2 No.
- New 110mm ø uPVC pipelines - ± 685m

- New 160mm ø uPVC pipelines - ± 1 730m
- New 200mm ø uPVC pipelines - ± 1 088m
- New 250mm ø uPVC pipelines - ± 1 820m
- New 315mm ø uPVC pipelines - ± 5 696m
- New 400mm ø uPVC pipelines - ± 890m
- New 406.4mm ø Steel pipelines - ± 14 970m
- New 508mm ø Steel pipelines - ± 2 750m
- Air valve chambers - 57 No.
- Scour valves - 29 No.
- Ancillary works to the above

A total of 29 629 m of pipe will be laid. Cumulatively, those pipes will construct a network of pipeline that produce the following section lengths (Figure 2);

- The major portion of the proposed pipeline scheme extends for approximately 23.3 km in an east-west direction.
- A shorter north-south oriented arm northwards approximately 2.1 km from the western margin of Chuniespoort to join up with the project.
- A ca. 1 km north-south oriented arm is located along the western bank of the Hlkaro River.
- A ca. 300 m long northwest-southeast oriented spur extends north of the main pipeline.
- A ca. 300 m long "L shaped" spur located west of Mamaolo extends southwards from the main pipeline.
- A ca. 280 m long segment located immediately north of Mamaolo (extending north-westerly from the top of a rounded hill).

The width of the area to be affected by the development is unknown to the author but is assumed, herein, to be less than 10 m (including any associated servitude road). The infrastructure (pumps *etc*) associated with the pipeline occupy extremely small aerial extents, and their location is immediately adjacent to the pipeline; as such these elements are discussion as part of the pipline.

8.3 Effect of project on the geology

The construction methods to be employed during the construction of the pipeline are unknown to the author. However, assuming a worst case scenario in which the pipeline is buried in a trench rather than being sited upon pylons it may be expected that any negative impacts associated with the trench would be restricted to the upper few meters of the land surface and result from the excavation of the trench. Any negative impacts associated with the development of associated servitude roads (assumed herein to be twin spoor dirt roads) would be restricted to the immediate upper 1-2 m of the land surface.

9 IMPACT ASSESSMENT

The potential impact of the proposed project 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 project's 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 potential 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 the structures and infrastructural elements that will constitute the water pipeline and its associated servitude road will be unavailable for scientific study for the life of the existence of those features. The life of the facility is expected to be permanent herein.

9.4 Probability of impact

The rocks of the Clarens Formation (Karoo Supergroup) are fossiliferous elsewhere in the region; as such, there is a moderate probability fossil materials occurring within any Clarens Formation rocks underlying the project area. However, it is pertinent to realise that fossils (particularly vertebrate fossils) are generally scarce and sporadic in their occurrence. However, the pipeline will disturb the land surface to a maximum width of 10 m and the area being affected is located along pre-existing roads within a township. Accordingly, any fossils that may have existed at surface will have been destroyed by historical human activity. Yet, it is possible that parts of the project may require excavations affecting the upper-most 1-3 m of the bedrock; given that fossil materials may be present in the rocks, the chances of fossil materials being negatively impacted in the Clarens Formation by the project is **low**.

The sediments of the Malmani Subgroup are richly fossiliferous, with stromatolites being extremely numerous in many parts of the unit. Thus, where the stromatolites occur they are extremely numerous and occur over large aerial extents. The probability of the project impacting negatively upon the stromatolites fossils is **high**.

The Duitschland Formation and Pretoria group rocks are unfossiliferous. The probability of the project resulting in a negative impact on the palaeontological heritage of the region is **nil**.

9.5 Significance of the impact

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.

From the discussion in Section 6.1.1.2 it is evident that the stromatolites within the rock unit exhibit morphological variation related to the environment of deposition. However, in any one particular area the stromatolites tend to be morphologically uniform. As such, in any particular area there will be large numbers of morphologically (and thus,

taxonomically) similar fossils. Given that, the area of impact of the pipeline will be only a probable maximum of 10 m wide and 1-2 m deep a modest proportion of the formation will be impacted. Accordingly, the significance of any negative impact caused by the project upon the stromatilite assemblages in any particular area will be **low** and large areas of morphologically and taxonomically identical stromatolites should remain in an undisturbed state.

The Duitschland Formation and Pretoria group rocks are unfossiliferous. The significance of any negative impact upon the palaeontological heritage of the region being caused by the project is **nil**.

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 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.

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

Sediments of the Clarens Formation underlie the western-most segment of the pipeline project. It is evident from Figure 6 that this segment of the pipeline lies within Mmaphelo Township. The pipeline is planned to be laid along existing roads within the township (Figure 6). Thus, total extent of the Clarens Formation that will be impacted by this project appears to have been historically disturbed by human activity. It is reasonably expected that any fossils that may have been located upon the land surface will have been destroyed. Accordingly, there is little value from performing a Phase 1 investigation prior to commencement of the project. However, any excavations that are

produced within this area for the emplacement of the pipelines may well expose scientifically valuable fossils. It is recommended, therefore, that all excavations that are produce into the Clarens Formation land surface within Mmaphelo Township should be inspected by a qualified palaeontologist before the pipes are laid and the trenches infilled with soil. 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 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 construction and the location of the pipeline moved.

No damage mitigation protocols are required to preserve the palaeontological heritage of the project area in those portions of the project that are underlain by the rocks of the Malmani Subgroup, Duitschland Formation or the Pretoria Group and none are suggested herein.

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 is potentially of the greatest scientific and cultural importance. Thus, the potential always exists during construction and excavation 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 and scientific literature; no direct observation was made of the area as result of a site visit.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop Palaeontological Impact Assessment Study has been conducted on the site of a proposed water supply pipeline proposed to be constructed for the town of Lekowakgomo, 48 km to the south of Polokwane. The major portion of the proposed pipeline scheme extends for approximately 23.3 km in an east-west direction. A shorter north-south oriented arm northwards approximately 2.1 km from the western margin of Chuniespoort to join up with the project. A ca. 1 km north-south oriented arm is located along the western bank of the Hlkaro River. A ca. 300 m long northwest-southeast oriented spur extends north of the main pipeline. A ca. 300 m long "L shaped" spur located west of Mamaolo extends southwards from the main pipeline. A ca. 280 m long segment located immediately north of Mamaolo (extending north-westerly from the top of a rounded hill). The project will consist of ca. 29 629 m of pipe that will be laid as well as the construction of necessary infrastructure (such as pumps). For the purposes of this report it was assumed that the maximum width of the area to be disturbed is 10 m and that the land surface will be excavated to a maximum depth of 1-2 m. However, any negative impacts to the palaeontological heritage of the region will be limited to the footprint area of the required infrastructure and the extent of any impacts is accordingly characterised as being local.

The majority of the project area is underlain by rocks of the late Achaean to early Proterozoic rocks of the Transvaal Supergroup. These units consist of the Chuniespoort Group (Malmani Subgroup and Duitschland Formation) and undifferentiated rocks of the Pretoria Group. Late Triasic/Early Jurassic sediments of the Clarens Formation (Karoo Supergroup) underlie the western-most extent of the project's infrastructure. The rocks of the Clarens Formation are known to be fossiliferous and to contain highly scientifically significant fossil assemblages. The probability of the project negatively impacting upon the fossil assemblages of the Clarens formation is low. The carbonate sediments of the Malmani Subgroup are richly fossiliferous, and contain abundant assemblages of stromatolites and the probability of the project impacting upon these is high; however, the significance of any such impact will be low. The Duitschland Formation and the rocks of the Pretoria group are unfossiliferous. The probability and significance of the palaeontological heritage of these units being negatively impacted is nil.

No damage mitigation protocols are required to preserve the palaeontological heritage of the project area in those portions of the project that are underlain by the rocks of the Malmani Subgroup, Duitschland Formation or the Pretoria Group and none are suggested herein.

The Clarens Formation contains scientifically important fossils that may be negatively impacted upon by the project. As such, any excavations that are produced within the portion of the project area underlain by the Clarens Formation, for the emplacement of the pipelines, may well expose scientifically valuable fossils. It is recommended, therefore, that all excavations that are produce into the Clarens Formation land surface within Mmaphelo Township should be inspected by a qualified palaeontologist before the pipes are laid and the trenches infilled with soil. 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 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 construction and the location of the pipeline moved.

This desktop study has not identified any palaeontological reason to prejudice the construction of the water supply pipeline project subject to the proposed damage mitigation procedures being implemented.

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2nd July 2017