DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT IN RESPECT OF A COAL MINE PROPOSED TO BE LOCATED ON THE FARMS BLOEMENDAL 283 IR, RIETFONTEIN 276 IR, NOOITGEDACHT 286 IR, POTFONTEIN 285 IR, AND VLAKFONTEIN 281 IR, 13 KM SOUTH-EAST OF SPRINGS, GAUTENG PROVINCE

12 August 2018

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On behalf of:

Topapix (Pty) Ltd

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 IN RESPECT OF A COAL MINE PROPOSED TO BE LOCATED ON THE FARMS BLOEMENDAL 283 IR, RIETFONTEIN 276 IR, NOOITGEDACHT 286 IR, POTFONTEIN 285 IR, AND VLAKFONTEIN 281 IR, 13 KM SOUTH-EAST OF SPRINGS, GAUTENG PROVINCE

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On Behalf of:

Totapix (Pty) Ltd

Prepared By:

Dr B.D. Millsteed

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. BM Geological Services reserves the right to modify aspects of the report including the recommendations if, and when, new information becomes available from ongoing research or further work in this field or pertaining to this investigation.

Although BM Geological Services exercises due care and diligence in rendering services and preparing documents, BM Geological Services accepts no liability, and the client, by receiving this document, indemnifies BM Geological Services against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by BM Geological Services and by the use of the information contained in this document.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must refer to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

COPYRIGHT

Copyright on all documents, drawings and records, whether manually or electronically produced, which form part of the submission and any subsequent report or project document, shall vest in BM Geological Services.

The client, on acceptance of any submission by BM Geological Services and on condition that the client pays to BM Geological Services the full price for the work as agreed, shall be entitled to use for its own benefit:

- The results of the project.
- The technology described in any report, and,
- Recommendations delivered to the client.

Should the applicant wish to utilise any part of, or the entire report, for a project other than the subject project, permission must be obtained from BM Geological Services to do

so. This will ensure validation of the suitability and relevance of this report on an alternative project.

EXECUTIVE SUMMARY

Totapix (Pty) Ltd has applied for a Mining Right to mine for coal on Portions 1, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14 and 16 of the farm Bloemendal 283 IR, Portion 3 and the Remaining Extent of the farm Rietfontein 276 IR, Portions 4, 5, 9, 12, 22, 28 and the Remaining Extent of the farm Nooitgedacht 286 IR, Portions 1, 2 and the Remaining Extent of the farm Potfontein 285 IR, and Portions 2 and 7 of the farm Vlakfontein 281 IR. The site is located 13 km south-east of Springs and 13.73 km north-east of Nigel, in both the Springs and Nigel Magisterial Districts, Sedibeng District Municipality, Lesedi Local Municipality, Gauteng Province. The agricultural holdings of Endicott and Vischkuil are located immediately north of the study area. The N17, R42 and the R550 run through the study area. The Mining Right area can be located within the confines of 1:50 000 topographic map 2628BC. The aerial extent of the Mining Right application area is 11 166 ha.

The complete extent of the Mining Right application area entails a life of mine of more than 50 years and covers the above-mentioned farm portions, although for the environmental authorisation (EA) application for which this report is required is only applicable to the first phase of the project. Phase one of the mining operation has an estimated life of mine of approximately nineteen years. Accordingly, only Portions 6, 9, 10, and 11 of the farm Bloemendal 283 IR and the Remaining Extent of the farm Rietfontein 276 IR will be applicable for this environmental authorisation (EA) application.

The aerial extent of the Mining Right application area is underlain by a lithologically diverse assemblage of stratigraphic units consisting of Swazian (Archaean) granite- gneiss of the Johannesburg Dome, predominantly siliciclastic sediments of the Hospital Hill Subgroup (and probably also the Government Subgroup), carbonate sediments of the Malmani Group, glaciogene sediments of the Dwyka Group, coal-bearing sediments of the Vryheid Formation and intrusive dolorite of the Karoo Dolorite Suite. It is interpreted that Cainozoic regolith forms the land surface over the majority of the Mining Right application area.

Due to the methodologies employed in the mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam 2 as the mine voids will not extend deeper than that. The maximum depth of this impact is unknown (but will probably be on the scale of 10's of meters). What is significant, however, is that the negative impacts will be constrained to the Vryheid Formation and any overlaying geological units. The nature and extent of the mining operations and the details and location of the associated infrastructure is only described, herein, for Phase one of the proposed mining operations; this is the area covered by the current environmental authorisation application. These details may well be different in subsequent phases of the life of mine. Accordingly, the findings of this report are valid only for the area covered by the current environmental authorisation application.

The required mine infrastructure, other than the two opencast pits, will all be located on the land surface. Of the non-opencast pit infrastructure the excavations required for the foundations for offices, a weighbridge, stormwater trenches and trenches to provide power and water access will result in the deepest impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m.

The rocks comprising the Swazian granite-gneiss, Hospital Hill Subgroup, Government Subgroup, and the Karoo Dolerite Suite are unfossiliferous. It is also interpreted, herein, that the interpreted Cainozoic regolith is unfossiliferous. Any impacts upon the rocks comprising these units caused by the progression of the mining operations will have a **negligible to nil** probability of resulting in a negative impact upon their palaeontological heritage. The carbonate sediments of the Malmani Group are fossiliferous, and are known to contain prolific stromatolite assemblages. The probability of any significance of any negative impact upon the palaeontological heritage of the Malmani Group is assessed high, but the significance is **low**. The sediments of the Vryheid Formation and the Dwyka Formation are known to contain plant macrofossil assemblages of the *Glossopteris* flora (the former also containing trace fossil assemblages). The significance of the fossil assemblages contained in these two units was assessed as **high**, but the probability of any negative impact is **moderate to good** for the Vryheid Formation and **low** for the Dwyka Group.

It is evident that the proposed mining operations pose a significant risk of negatively impacting upon scientifically highly significant fossil assemblages and damage mitigation protocols are required. Accordingly, it is recommended that:

- A thorough field investigation be conducted by an appropriately experienced Karoo palaeontologist prior to the commencement of the project in the area identified in the current environmental authorisation application and a Full Palaeontological Impact assessment report be submitted to SAHRA.
- This would allow a meaningful evaluation of the presence of fossil materials being present at surface.
- If fossil materials prove to be present the process would allow the identification of any scientifically significant fossils and resultant recommendations that they should be either be protected completely *in situ* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

It was identified above (see Section 9.1) that the disruption of the geological strata underlying the project area will result in the complete and permanent disaggregation and destruction of the geological strata from the land surface to the complete depth of the in the mine voids. This in effect means that in the two areas identified for opencast mining The Vryheid Formation will be completely destroyed down to the base of Seam 2.

It is recommended that once excavation of the pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted every six months by an appropriately experienced Karoo palaeontologist.
- The frequency of these checks should be assessed after six months based on the findings and the planned mining programme.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.
- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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 could be protected and the site of any planned construction moved.

Should scientifically or culturally significant fossil material exist within the project areas 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 could be protected and the site of any planned construction moved.

This desktop study has not identified any palaeontological reason to prejudice the progression of this project subject to the recommended damage mitigation protocols outlined above being instituted.

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

Totapix (Pty) Ltd has applied for a Mining Right to mine for coal on Portions 1, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14 and 16 of the farm Bloemendal 283 IR, Portion 3 and the Remaining Extent of the farm Rietfontein 276 IR, Portions 4, 5, 9, 12, 22, 28 and the Remaining Extent of the farm Nooitgedacht 286 IR, Portions 1, 2 and the Remaining Extent of the farm Potfontein 285 IR, and Portions 2 and 7 of the farm Vlakfontein 281 IR. The site is located 13 km south-east of Springs and 13.73 km north-east of Nigel, in both the Springs and Nigel Magisterial Districts, Sedibeng District Municipality and Lesedi Local Municipality, Gauteng Province. The agricultural holdings of Endicott and Vischkuil are located immediately north of the study area. The N17, R42 and the R550 run through the study area (Figure 1). The Mining Right area can be located within the confines of 1:50 000 topographic map 2628BC. The aerial extent of the Mining Right application area is 11 166 ha.

The complete extent of the Mining Right entails a life-of-mine of more than 50 years and covers the above-mentioned farm portions, although for the environmental authorisation (EA) application for which this report is required is only applicable to the first phase of the project. Phase one of the mining operation has an estimated life-of-mine of approximately nineteen years. Accordingly, only Portions 6, 9, 10, and 11 of the farm Bloemendal 283 IR and the Remaining Extent of the farm Rietfontein 276 IR will be applicable for this environmental authorisation (EA) application (Figure 2).

Totapix (Pty) Ltd has appointed Enviro-Insight CC to undertake environmental authorisations associated with the proposed Bloemendal Coal Mine. Enviro-Insight CC has appointed Heritage Contracts and Archaeological Consulting CC, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process for this coal mining project. Heritage Contracts and Archaeological Consulting CC has retained 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.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- 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.

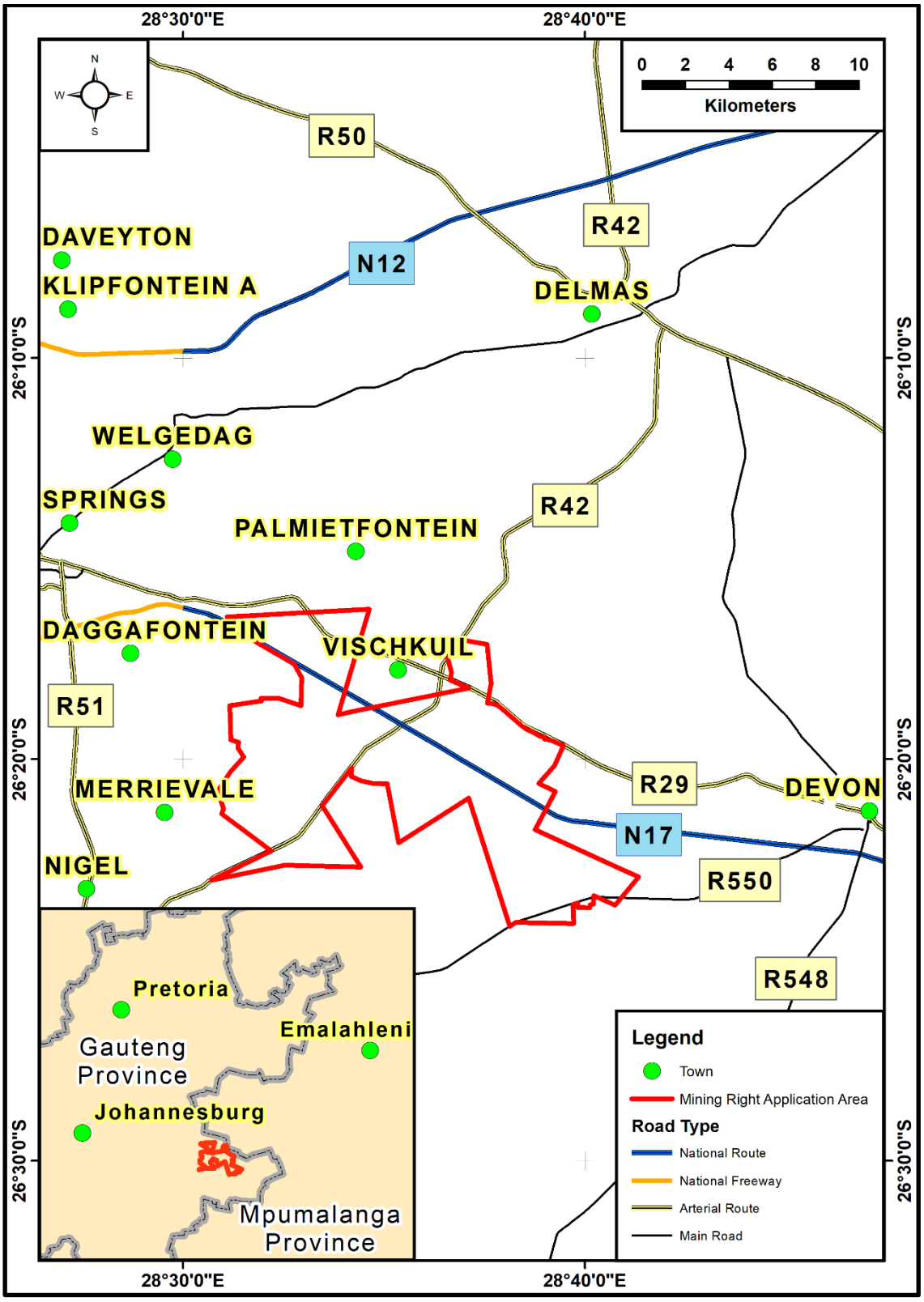

Figure 1: The location of the Mining Right application area.

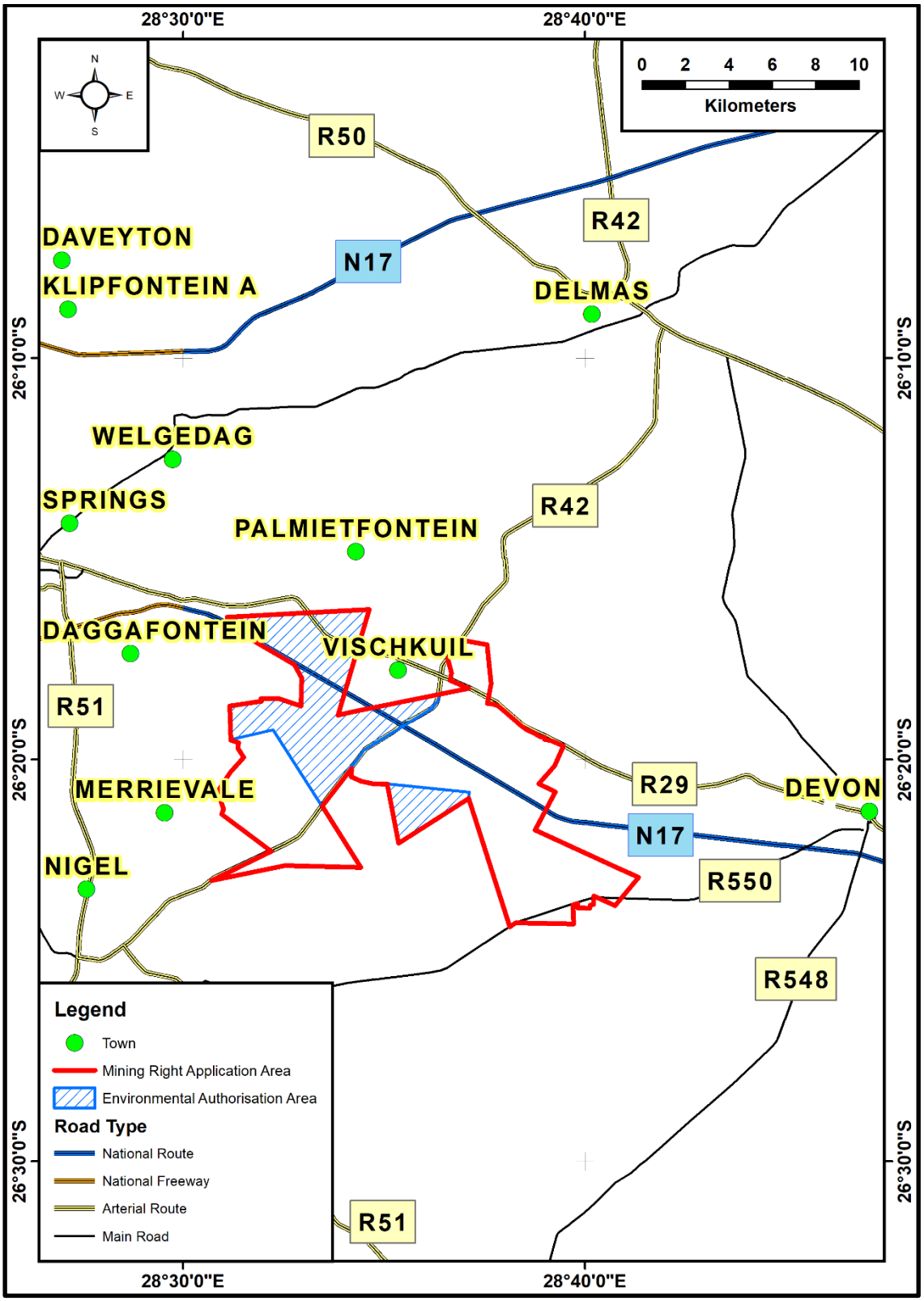

Figure 2: Map showing the location of the environmental authorisation application area within the Mining Right application area.

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]

The National Environmental Management 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 this act 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; Reg. No. 400332/07), is a member of the Palaeontological Society of South African and the Association of Australasian Palaeontologists and is also a Fellow of the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this desktop 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 in either Totapix (Pty) Ltd, the proposed mining operations, nor any companies or individuals associated with the mining project.

6 GEOLOGY AND FOSSIL POTENTIAL

The Mining Right application area is completely underlain by Mesoarchaean (Swazian) granitic rocks of the Johannesburg Dome, Archaean (Randian) predominantly siliciclastic sediments of the Hospital Hill and probably of the overlying Government Subgroups (Witwatersrand Supergroup), and the Palaeoproterozoic carbonates of the Malmani Subgroup of the Transvaal Supergroup (Figure 3). These units collectively form the basement to the Early Permian, coal-bearing strata of the Vryheid Formation (Karoo Supergroup). The basement succession as well as the Vryheid Formation is intruded by the rocks of the Karoo Dolorite Suite (Figure 3). A pervasive Cainozoic regolith horizon is interpreted to for the land surface over the majority of the Mining Right area. A brief description of the geology of the Mining Right application area and the palaeontological potential of those geological units is provided below.

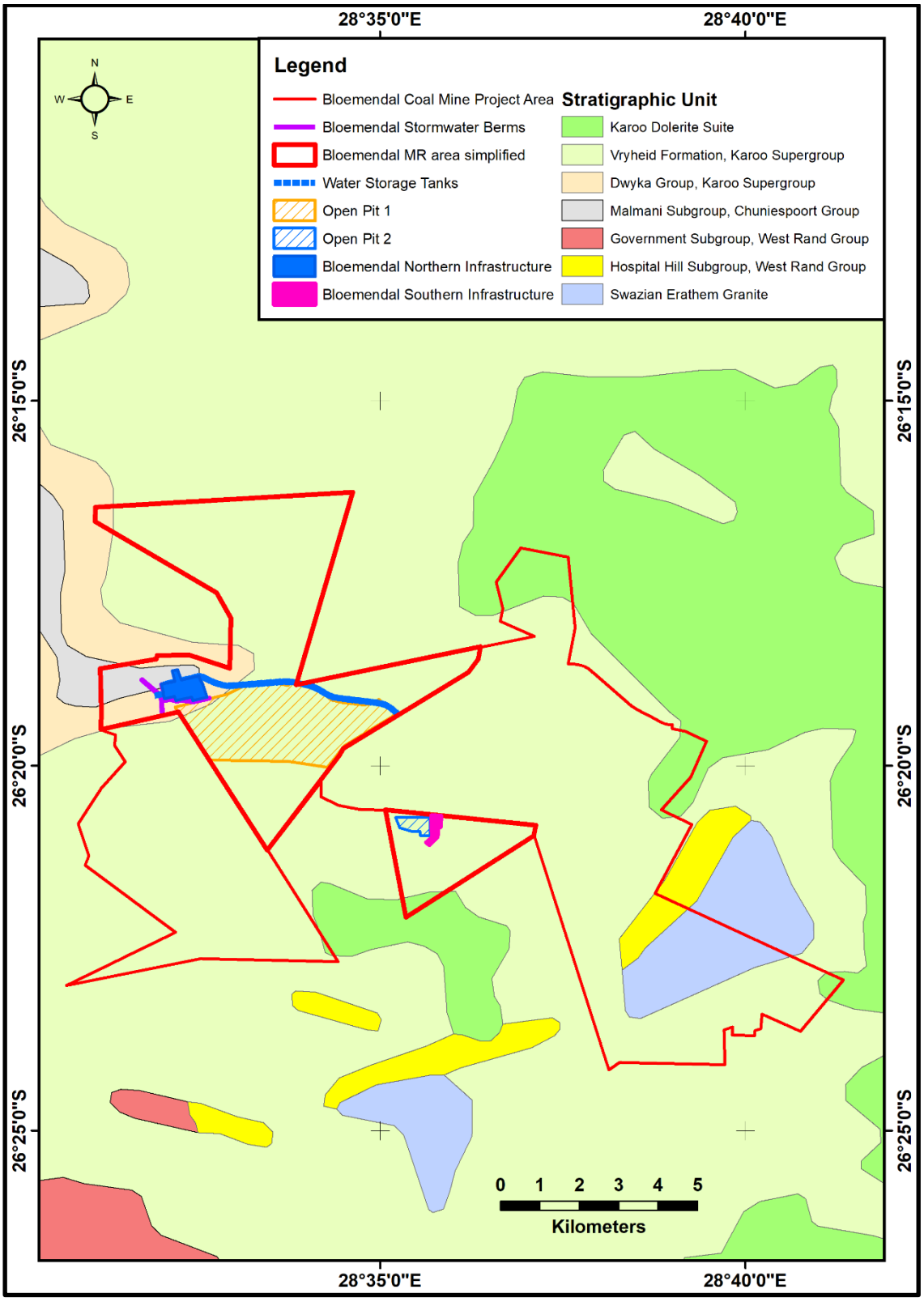

Figure 3: Map of the bed rock geology of the Mining Right application area and its surrounding environs.

6.1 Swazian Granite-gneiss

6.1.1 Geology

The Swazian-age (Mesoarchaean) granite-gneiss rocks present in the Mining Right application area form part of the Johannesburg Dome succession; the Johannesburg Dome forms part of the Kaapvaal Craton. The rocks underlying the project area consist of felsic, intermediate composition rocks and comparison to Figure 18 of Robb *et. al*., (2006) suggests that the rocks within the project area consist of homogeneous, medium-grained gneiss of granodiorite composition.

6.1.2 Palaeontological potential

The plutonic, intrusive rocks of the Johannesburg Dome are formed by solidification of magma at great depth within the Earth's crust. The gneissic textural fabric present within the unit represent subsequent tectonic deformation and metamorphism. The potential for these rocks to contain palaeontological materials is nil.

6.2 Hospital Hill Subgroup

6.2.1 Geology

The Archaean (Randian) rocks of the Hospital Hill Subgroup (West Rand Group, Witwatersrand Supergroup) constitute the basal portion of the basin infill sequence of the Witwatersrand Basin. The unit consists of a > 1 500 m thick succession of predominantly of shallow-marine orthoquartzites and more distal siltstones and outer-shelf shales and banded iron formation (McCarthy, 2006). The unit is predominantly argillaceous in composition.

6.2.2 Palaeontological potential

The rocks of the Hospital Hill Subgroup are known to be unfossiliferous.

6.3 Government Subgroup

6.3.1 Geology

The Archaean (Randian) strata of the Government Subgroup do not crop out within the Mining Right application area (Figure 3), but do crop out to the south-west of the application area. The outcrop patterns in the region do suggest that the there is a significant chance that this unit may well sub-crop beneath the Vryheid Formation in the central portions of the Mining Right application area. The rocks of the Government

Subgroup (West Rand Group, Witwatersrand Supergroup) are the most lithologically diverse unit in the West Rand Group. The rocks of the unit form a > 1 600 m thick succession ranging from conglomerate to banded iron formation as well as a number of diamictite horizons (McCarthy, 2006), but the unit is dominated by arenaceous lithologies. Successive falls in sea-level and the progradation of fluvial (braided stream) environments resulted in the deposition of higher energy sands and conglomerates of the Government Subgroup, compared to the finer-grained, deeper water derived sediments of the underlying Hospital Hill Subgroup.

6.3.2 Palaeontological potential

The rocks of the Government Subgroup are known to be unfossiliferous.

6.4 Malmani Subgroup

6.4.1 Geology

The Palaeoproterozoic rocks of the Malmani Subgroup (Transvaal Supergroup) are up to 2000 m thick and form part of the basin infill sequence of the Transvaal Basin. The unit is subdivided into five formations based on their chert content, stromatolite morphology, intercalated shales and erosion surfaces (Eriksson *et. al*., 2006). The formations that comprise the Malmani Group (in ascending stratigraphic order) are the Oaktree, Monte Cristo, Lyttelton, Eccles and the Frisco Formations (Eriksson *et. al*., 2006).

The Malmani carbonates reflect three major transgressive-regressive macrocycles, upon 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. The fundamental subdivisions of the Malmani Subgroup are based on the recognition of two main lithofacies. The first is a pale grey, chert-rich dolomite (Eccles and Monte Cristo Formations) 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 (the Frisco, Lyttelton and Oaktree Formations). The particular formation(s) that underly the proposed project infrastructure is unknown to the author.

6.4.2 Palaeontological potential

The only macrofossil types known to occur within the Malmani Subgroup are stromatolites, but these occur throughout the succession. The pale chert–rich units are believed to comprise tidal-flat and shallow subtidal environments whereas the dark grey to black,

chert-poor units are deeper water subtidal deposits, as indicated by the large size of some of the stromatolitic mounds.

As indicated above, variation has been observed in the size and morphology of the stromatolites assemblages across the Transvaal Basin. However, from the author's personal observations, where stromatolites occur within the Malmani Subgroup in any particular area they tend to be prolific, but morphologically uniform.

6.5 Dwyka Group

6.5.1 Geology

The Late Carboniferous to Early Permian sediments of the Dwyka Group rest upon glacially striated basement surfaces in numerous locations around South Africa. The associated striated pavements as well as the combination of lithological characteristics (with the presence of diamictite, drop stones and varves perhaps being the most significant) and other sedimentary structures testify to a glacial origin for the unit. The Dwyka Group has been stratigraphically differentiated across the Main Karoo Basin of South Africa into the Mbizane and Elandsvlei Formations. The Mbizane Formation consists of buff to grey coloured sediments that are rich in Kaolinite. The unit is characterised by rapid thickness changes, highly variable lithology, and a marked abundance of mudrock (ca. 40%) compared to massive diamictite (ca. 20%). The Mbizane Formation occurs in the northern margins of the Main Karoo Basin and extends well to the north of the basin and represents a continental valley inlet facies (Johnson *et. al*., 2006). The southern marine platform facies of the basin is termed the Elandsvlei Formation. The Elandsvlei Formation exhibits a progressive thickening towards the south into the marine basin. Lithologically the Elandsvlei Formation is reasonably uniform with a high massive diamictite (ca. 70%) and low massive mudstone (ca. 8%) content. The sediments of the Elandsvlei Formation tend to be dark green (in fresh samples) due to a significant chlorite content (Johnson *et. al*., 2006). The rocks present beneath the project area probably belong to the Mbizane Formation.

6.5.2 Palaeontological potential

The sediments of the Dwyka Group and its stratigraphic equivalents elsewhere in southern Africa are not richly fossiliferous, but are known to contain uncommon elements of the *Glossopteris* flora. Where present in the glacial strata of the region the plant macrofossil material appears to be concentrated in laminated fluvioglacial to fluviolacustrine facies. The plant macrofossil assemblages to be expected within the Early Permian strata of South Africa have been summarised by Bamford (2004).

6.6 Vryheid Formation

6.6.1 Geology

The Main Karoo Basin consists of a retro-arc foreland basin filled with a lithological succession ranging in age from the Late Carboniferous to the Middle Jurassic (Johnson *et. al*., 2006). The basin-fill sequence wedges out northwards over the adjacent Kaapvaal Craton.

In the Main Karoo Basin of South Africa, the Vryheid Formation is a sandstone and coal-rich stratigraphic unit that interfingers with (i.e., is transitional with and partially time equivalent to) the overlying Volksrust and underlying Pietermaritzburg Formations; both of which are both are predominantly argillaceous (Figure 4). Genetically the formation can be divided into lower fluvial-dominated deltaic interval, a middle fluvial interval (the coal-bearing zone) and an upper fluvial-dominated deltaic interval (Johnson *et. al*., 2006). The thickness and frequency of the sandstone units increases from the base of the formation, reaching their maximum in the middle fluvial interval and then decrease again towards the overlying Volksrust Formation. To the south and south-east the Vryheid Formation grades laterally into undifferentiated, deep-water argillites of the Ecca Group (Figure 4).

The Vryheid Formation is one of sixteen (16) recognised stratigraphic units that constitute the Permian Ecca Group. During the deposition of the Ecca Group the basin was dominated by a large sea (the salinity levels of this water body remain unresolved). The exception to this model was the deposition of the coal-bearing strata of the Vryheid Formation along the northern margin during an episode of deltaic progradation into the basin.

Deposition of the Vryheid Formation was terminated by a basin-wide transgression that drowned the Vryheid deltas and their coal swamps resulting in the deposition of the deep-water sediments of the Volksrust Formation.

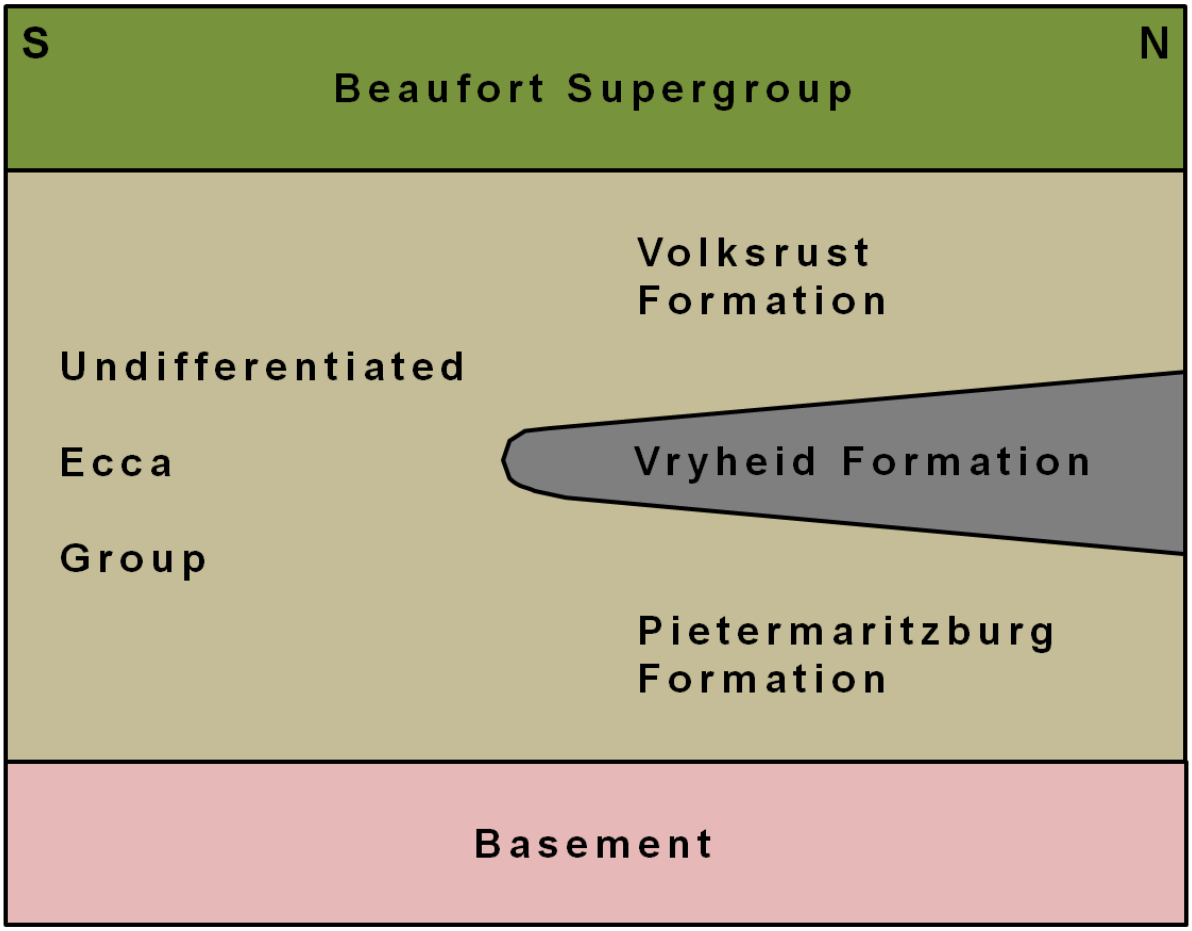

Figure 4: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

6.6.2 Palaeontological potential

The most conspicuous and common components of the palaeontological record of the Ecca Group in, general, are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Vryheid Formation) *Gangamopteris* has ceased to occur with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by Drs E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general

and the Vryheid Formation in particular is presented in Bamford (2004). In that summary it is indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthelezia*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylon* and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith *et. al*., (1988) where it was noted that both *Glossopteris* and *Vertebraria* occur within the palaeontological record of the formation.

In portions of the formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being *Coelacanthus dendrites* from the Somkele coal-field of northern Natal and *Namaicthys digitata* from correlative strata in the Senge Coal-fields of Zimbabwe. While fish faunas are obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation.

Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage they identified two forms (*Helminthiopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep-water *Nerites* community.

No fossil materials were identified within the Vryheid Formation sandstone outcrops located within the study area. However, the possibility that the formation contains fossils remains. Similarly, it is possible that argillaceous strata (that have a higher fossil-bearing potential than the sandstone facies) may be present in the area. The possibility exists, therefore, that fossils, particularly those of the *Glossopteris* flora may be present within the project area.

6.7 Karoo Dolerite Suite

6.7.1 Geology

The intrusive dolerite rocks of the Karoo Dolerite Suite are present throughout the Main Karoo Basin as a series of dykes and sills. These Jurassic dolerites (emplaced approximately 183 ± 2 Ma) represent the remnants of the feeder system to the flood basalt eruptions that forms the lavas of the Drakensberg Group that cap the Drakensberg Mountains (Duncan and Marsh, 2006).

6.7.2 Palaeontological potential

Dolerite is a hypabyssal, intrusive igneous rock type; as such there is nil potential for any fossil material to be located within this rock unit.

6.8 Cainozoic Regolith

6.1.1 Geology

Examination of Google earth imagery (Figure 5) reveals that the land surface overlying the project area is extensively covered by vegetation. There is an area located west of Vischkuil, located between the southern side of the R29 road and a mine slimes dam that has been reclaimed by mining, which has a small township and an informal settlement built upon it. The reminder of the area has been utilised for cultivation and has been ploughed. The presence of the almost uniform coverage of the project area by cultivated (ploughed) land implies an equally uniform coverage of Cainozoic regolith horizon.

6.1.2 Palaeontological potential

The Blesbokspruit is located to the west of the Mining Right application area (which with the associated Blesbokspruit Ramsar Site and the Marievale Bird Sanctuary) is immediately adjacent to the boundary of the Mining Right application area. The author has personally visited the Marievale Bird Sanctuary and numerous locations along the Blesbokspruit in the past. During these visits no potentially, fossiliferous fluvial terraces were observed.

Despite the proximity of the project area to the Blesbokspruit it is considered unlikely that the regolith underlying the project area is of fluvial origin and, thus, potentially fossiliferous. It is more likely that the genesis of the regolith is the result of *in situ* decomposition of the immediately underlying bedrock. Of the various lithological units underlying the Mining Right application area only the Vryheid Formation and the Dwyka Group strata (to a much lower probability) are potentially fossiliferous. No fossil materials could be inherited from the underlying unfossiliferous units by the regolith, and where the bedrock is either the Vryheid Formation or the Dwyka Group any fossil material would potentially have been destroyed by the weathering processes. Taking all of the preceding discussion into account the probability of the regolith horizon being fossiliferous is considered to be negligible.

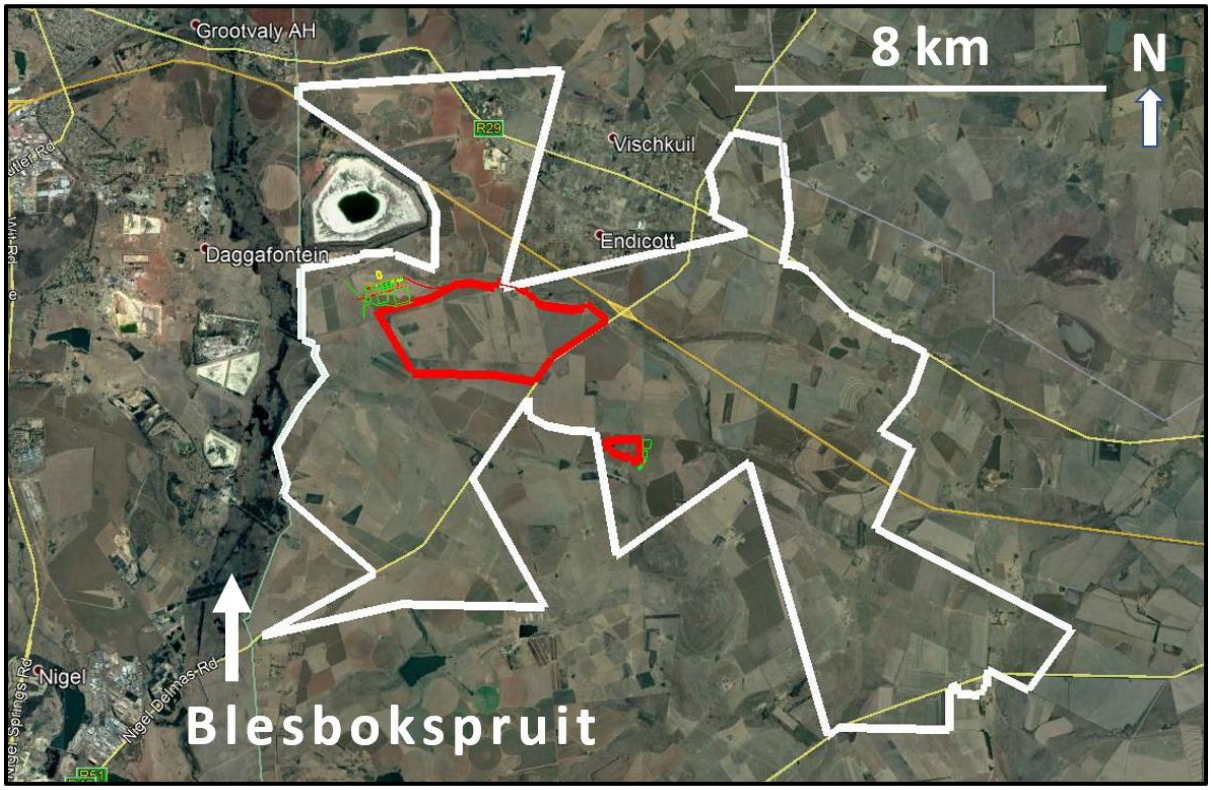

Figure 5: Google earth image of the Mining Right application area (white polygon). The two proposed opencast pits are shown in the red polygons. The areas of green polygons located on the northern margin of the northern pit and the southern margin of the southern pit represent the areas where the mine's surface infrastructure is planned.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The environment of the Mining right application area and the surrounding environs is shown in Figure 6. It is evident in Figure 6 that the Mining Right application area is topographically reasonably flat and featureless. The Blesbokspruit flows immediately to the west of the project area and the associated Blesbokspruit Ramsar site and the Marievale Bird Sanctuary partially form the western margin of the Mining Right area. A number of significant perennial and ephemeral fluvial drainage lines traverse the project area, where they drain to the west and flow into the Blesbokspruit. Numerous ephemeral pans are also distributed across the Mining right application area (Figure 6). The Vischkuil Agricultural Holdings occur immediately adjacent to the north-eastern boundary of the project area (Figure 6). It is evident from Figure 7 that immediately to the west of the Vischkuil Agricultural Holdings is a section of informal township that lies within the boundary of the project area. The Mining Right application area is traversed by a number of roads with the most significant being the N17, R29 and R42 (Figure 6).

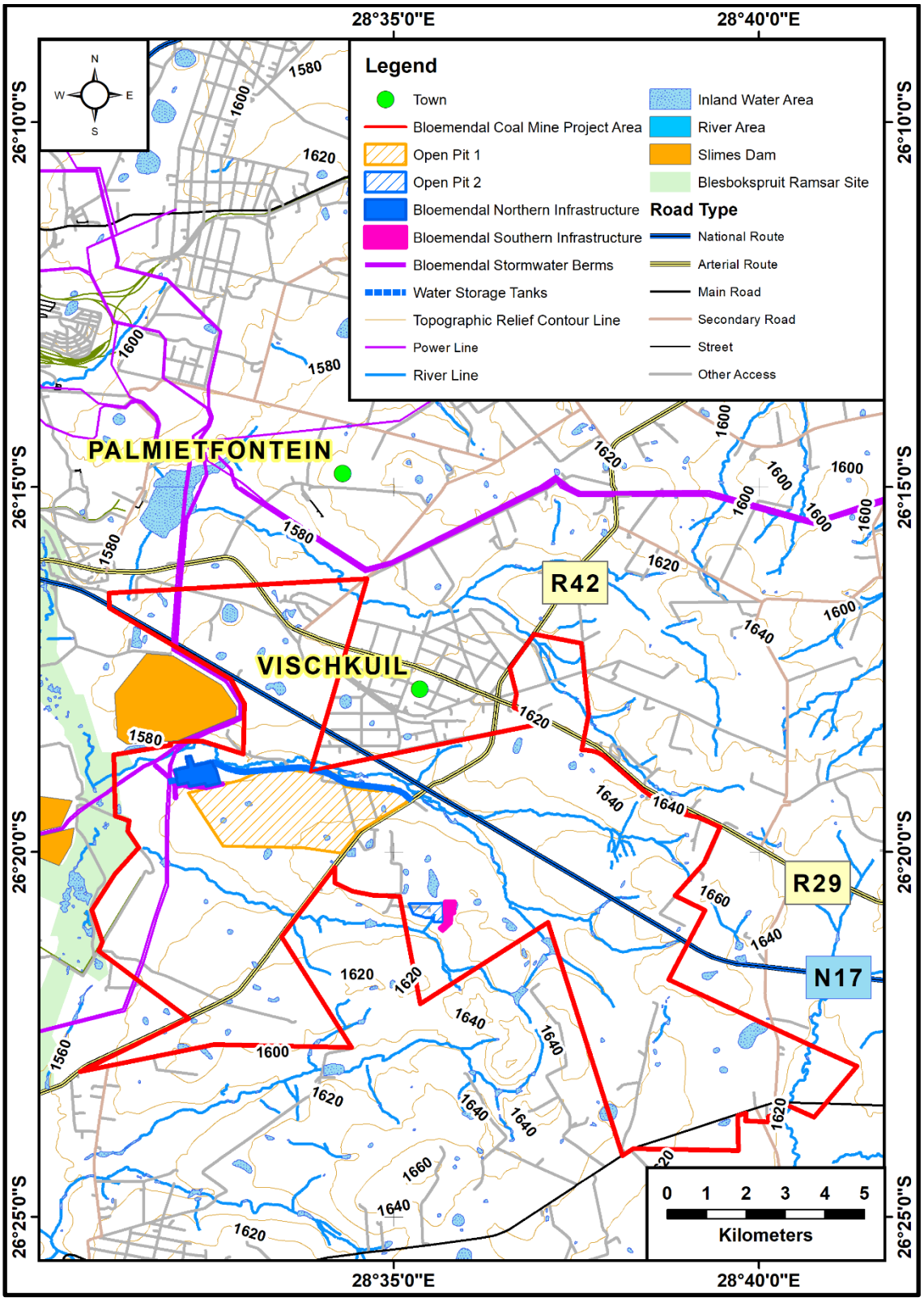

Figure 6: The environment of the area underlying the Mining Right application area (red polygon), the proposed mining infrastructure and the surrounding environs. The topographic relief contour interval for the map is 20 m.

Almost the entire extent of the Mining Right application area is underlain by vegetation of the Soweto Highveld Grassland biome. Small areas along the western margin of the Mining Right application area bear a vegetation of the Eastern Temperate Freshwater biome (as well as one isolated location towards the south-eastern end of the application area). Associated with the Eastern Temperate Freshwater are areas of Andesite Mountain Bushveld (Figure 8). The distribution of the Eastern Temperate Freshwater and the Andesite Mountain Bushveld is associated with the channel of the Blesbokspruit and its banks (Figure 6). Mucina and Rutherford (2006) describe the conservation status of the Soweto Highveld Grassland as endangered, while that of the Eastern Temperate Freshwater and the Andesite Mountain Bushveld is described as least threatened. It is apparent from Figure 5 that none (or almost none) of the original Soweto Highveld Grassland remains extant within the Mining Right application area; the area has been historically extensively utilised for cultivation and the area has been almost completely ploughed.

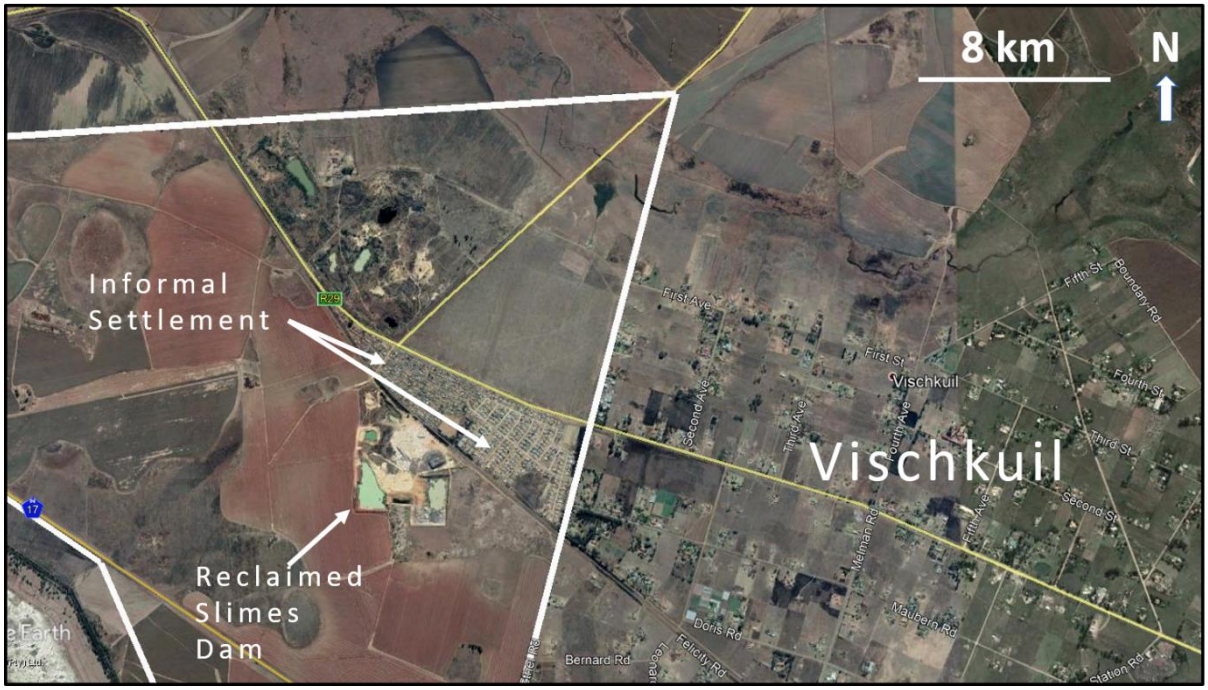

Figure 7: Google earth image of the northern extent of the Mining Right application area (white polygon). Shown is the location of the Vischkuil Agricultural Holdings; an informal settlement and a reclaimed slimes dam located within the application area.

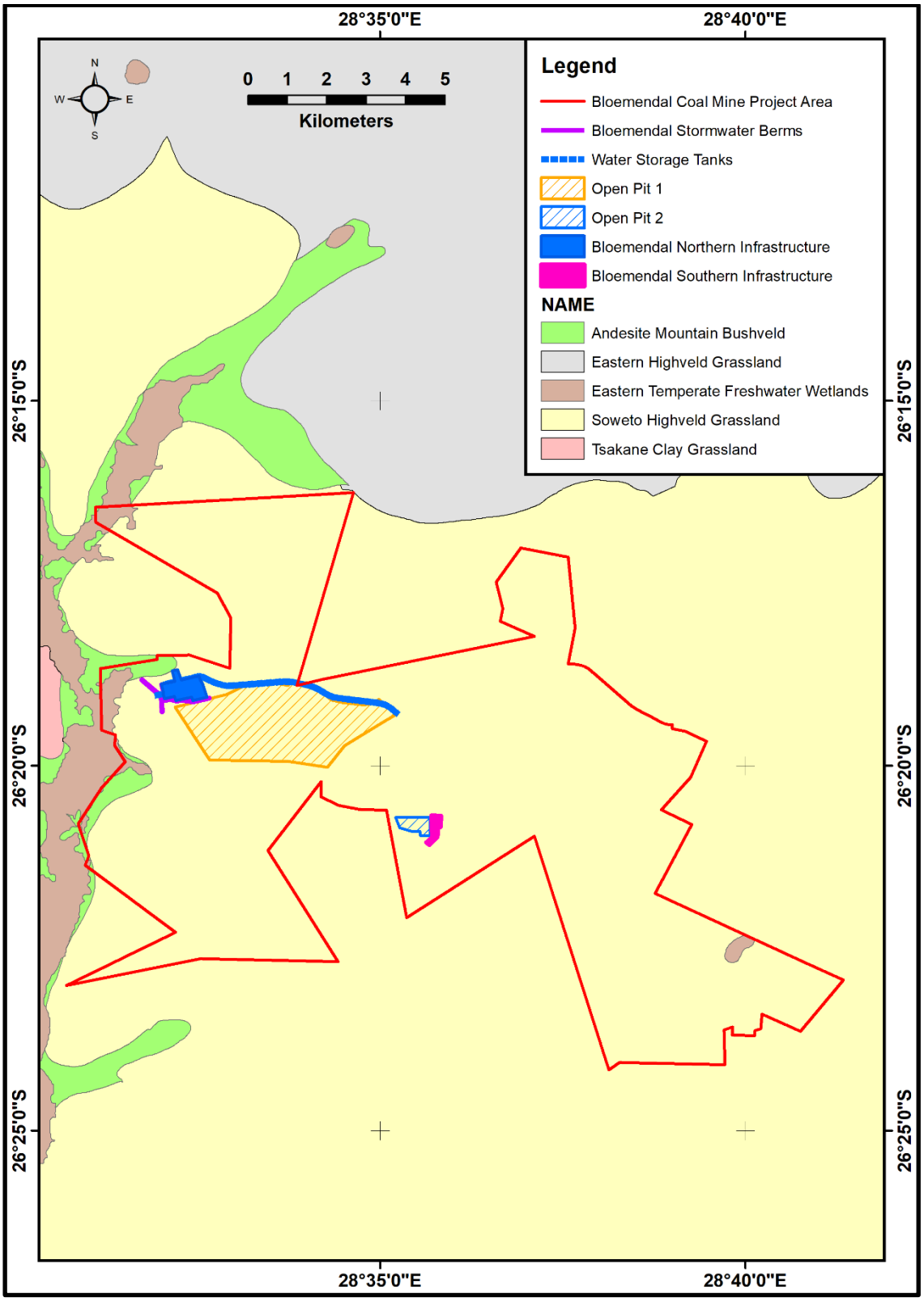

Figure 8: Vegetation types underlying the Mining Right application area, the proposed mine infrastructure and the surrounding environs (modified from Mucina and Rutherford, 2006).

8 OVERVIEW OF SCOPE OF THE PROJECT

There are two clearly identifiable coal seams, Seams 2 and 4, and rarely Seam 1 that have been identified underlying the project area and which form part of the Vryheid Formation. Geologically, the three seams are distributed vertically with Seam 4 occurring above Seam 2, and Seam 1 (where it occurs) underlies the other two. Seam 1 occurs at the base of the Vryheid Formation within erosional palaeodepressions and valleys incised into the underlying Dwyka Formation. For this application, the coal seams will be mined via two opencast pits (approximately 730 ha in total extent).

8.1 infrastructure

The proposed infrastructure required on site includes the following:

- Access & Haul roads (with necessary security) including the upgrading of the access point to the gravel road;
- Contractor's Yard with septic/chemical ablution facilities;
- Offices;
- Weighbridge, workshop and stores (with septic/chemical ablution facilities);
- Rail Siding;
- Diesel facilities and a hardstand;
- Power and Water;
- Boxcut;
- Stockpiles (topsoil, overburden, subsoil/softs, Run of Mine);
- Surface water management measures (stormwater diversion berms and trenches, pollution control dams, tailings dam etc);
- Crushing, screening & wash facility and;
- Tailings facility.

8.2 Mining method

The proposed mining method and sequence comprised of the following main mining activities for both waste and coal:

- Initial topsoil and soft overburden removal which will be stockpiled to ensure it can be replaced back in the initial box cut;
- The physical mining of the coal seam which includes drilling of hard overburden material, charging and blasting;
- The coal is loaded into trucks and hauled to the crushing and screening facility;
- Discard coal will be extracted and replaced in the bottom of the opencast pit, while the product will be taken to the weighbridge via trucks and then removed off site;
- The overburden is replaced back into the pit as mining progresses leaving a minimum area of the void open at a single time;

- The topsoil which was stripped and stockpiled separately before mining commenced is then replaced. The findings of the land capability study will determine the optimal composition to ensure pre-mining conditions for utilisation.

8.3 Impact upon the geology

The proposed mining operations will be conducted by opencast mining (two open cast pits will be developed) and will exploit both Seams 2 and the overlying Seam 4. Accordingly, the mining operations will result in the total extraction and transport of all geological materials occurring between the land surface and the base of Seam 2. For the purposes of palaeontology any fossil materials contained in the mined rocks can be treated as being destroyed. Due to the methodologies employed in the mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam 2. The maximum depth of this impact is unknown (but will probably be on the scale of 10's of meters). What is significant, however, is that the negative impacts will be constrained to the Vryheid Formation and any overlaying geological units.

The required mine infrastructure, other than the two opencast pits, will all be located on the land surface. Of the non-opencast pit infrastructure, the excavations required for the foundations for offices, a weighbridge, stormwater trenches and trenches to provide power and water access will result in the deepest impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m.

The following impact assessment (Section 9) is made in the light of these assumptions.

9 IMPACT ASSESSMENT

The potential impact of the Totapix (Pty) Ltd opencast coal mining project 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 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 **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 **long term to permanent**. 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 may exist below the structures and infrastructural elements that will constitute the coal mining operation will be unavailable for scientific study for the duration of the existence of those features.

9.4 Probability of impact

It is pertinent to realise that fossils are generally scarce and sporadic in their occurrence and, as such, the probability of any development affecting a fossil at any particular point on the land surface in relatively low. However, the strata of the Swazian granite-gneiss, the Hospital Hill Subgroup, Government Subgroup and the Karoo Dolerite Suite are unfossiliferous. The probability of any negative impact resulting upon the palaeontological heritage of these units caused by the mining project is assessed as being **nil**. It is also pertinent to note that the outcrops of these units lie outside of the area that will be affected by Phase one of the mining operation (i.e., the area being assessed for the current environmental authorisation application).

The predominantly carbonate sediments of the Malmani Group are well known for the prolific stromatolite assemblages they contain throughout the unit. The probability of the

proposed mining operations impacting upon the palaeontological heritage of this unit is accordingly assessed as being **high** where the operations do actually impact upon the unit. However, only the area marked in Figure 3 as "northern infrastructure area" will impact the rocks of the Malmani Group and this area is of relatively small aerial extent. Similarly, in this area only the surface infrastructure will be emplaced, and the maximum depth of impact over most of the area will be < 2 m. The net result is that a relatively minor volume of the rocks of this the Malmani Group rocks will be affected.

The sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora as well as trace fossil assemblages. However, the occurrence of fossils within the geological record is erratic in general and the chance of impacting upon most macrofossil types at any particular point within the Vryheid Formation is low. It must be noted however, that where plant macrofossils or trace fossils are present within a sequence (as they are elsewhere in the Vryheid Formation) they are often in dense accumulations. The probability of a negative impact upon the palaeontological heritage of the unit arising from the mining operations is accordingly assessed as being **moderate to good**. The rocks of the Dwyka Formation are poorly fossiliferous, but they are they also known to rarely contain plant macrofossils of the *Glossopteris* flora. The probability of the palaeontological heritage of the unit being negatively impacted is assessed as **low**. It should also be noted that, as with the Malmani Group, this unit will only be affected by the built infrastructure contained in the "northern infrastructure area". Similarly, only a relatively minor volume of the stratigraphic unit will be negatively impacted.

The presence of a Cainozoic regolith cover underlying the project area is interpreted herein (see Section 6.8 above). It is anticipated that this regolith is derived from *in situ* decomposition of the underlying bedrock. The probability of any fossil materials having been originally present within the regolith is assessed as **negligible**. However, it is evident in Figure 5 that the entire extent of the Mining Right application area has been cultivated (ploughed) and the land surface has been overturned (multiple times) to the depth of a plough blade. Should any fossil materials have originally existed in the regolith at surface prior to cultivation, they will now have been destroyed.

9.5 Significance

Should the project progress without due care to the possibility of fossils being present within either the bedrock or regolith the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. The rocks of the Vryheid Formation are well known to contain highly scientifically significant plant macrofossil assemblages of the *Glossopteris* flora as well as trace fossil assemblages. Thus, the sediments of the Vryheid Formation provide an important window into the evolution the of plant life that constitutes the famous *Glossopteris* flora during this poorly understood interval in the Early Permian within the Main Karoo Basin. Their significance is due to the

uniqueness of their terrestrial environments within the basin fill of the Main Karoo Basin at that time. Thus, any fossil materials occurring within the project areas are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**. The trace fossil assemblages contained within the unit are not as significant as the plant macrofossils as, while they may be present in large numbers they tend to be taxonomically depauperate. They, do provide important palaeoenvironmental data. The Dwyka Group sediments are also known to rarely contain plant macrofossils of the *Glossopteris* flora. Just as in the Vryheid Formation, these fossils are assessed as having a **high** scientific significance. However, due to the slightly older age of this unit and the rarity of macrofossils occurring within it, the significance of the any scientific insights gained from any such fossils would be even greater than in the Vryheid Formation.

The stromatolite assemblages of the Malmani Group are extremely abundant, and do show morphological availability across the Transvaal Basin. However, in any particular area they tend to be morphologically similar. Thus, the significance of any negative impact upon the palaeontological heritage of a small area of the Malmani Group is assessed as being **low**.

The rocks of the Swazian granite-gneiss, the Hospital Hill Subgroup, Government Subgroup, the Karoo Dolerite Suite and the regolith cover are unfossiliferous. The significance of any negative impact resulting upon the palaeontological heritage of these units is assessed as being **nil**.

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

Most of the area which is the subject of the Mining Right application area has been cultivated (ploughed). However, there are significant fluvial drainage lines that traverse the area (which may have exposed bedrock in their channels and margins) and the area underlying the northern infrastructure area is located upon the southern flanks of a slightly raised topographic feature where there may also be surface erosion. There should be areas of bedrock outcrop visible as these rocks were mapped at surface. Accordingly, it is recommended that:

- A thorough field investigation be conducted by an appropriately experienced Karoo palaeontologist prior to the commencement of the project, in the area identified in

the current environmental authorisation application, and a Full Palaeontological Impact assessment report be submitted to SAHRA.

- This would allow a meaningful evaluation of the presence of fossil materials being present at surface.
- If fossil materials prove to be present the process would allow the identification of any scientifically significant fossils and allow resultant recommendations that they should be either be protected completely, *in situ,* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

It was identified above (see Section 9.1) that the disruption of the geological strata underlying the project area will result in the complete and permanent disaggregation and destruction of the geological strata from the land surface to the complete depth of the mine voids. This in effect means that in the two areas identified for opencast mining the Vryheid Formation will be completely destroyed down to the base of Seam 2.

It is recommended that once excavation of the pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted every six months by an suitably experienced Karoo palaeontologist.
- The frequency of these checks should be assessed after six months based on the findings and the planned mining programme.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.
- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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 could be protected and the site of any planned construction moved.

10.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials or the reduction of their scientific value due to a loss of their 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**.

By their nature 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 may be of the greatest scientific importance; this is particularly true of vertebrate fossils in which many taxa are known from only one fossil. 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 the result of a site visit. In particular, the discussion of the geological units occurring beneath the project area infrastructure (and as such the basis of understanding the fossiliferous potential of the area and the extent of any negative impact upon the palaeontological heritage of the area) was derived from the published 1:250 000 geological maps of the area. The accuracy of 1:250 000 geological maps is often variable; some areas being compiled from air photo interpretation or remote sensing procedures. The possibility of the presence of additional geological units being present within the project area cannot be disregarded.

The presence and mode of formation of the Cainozoic regolith interpreted to be underlying the project area has been hypothesised from available evidence and the authors knowledge of the area and not by direct observation.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of a Mining Right application to mine for coal on Portions 1, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14 and 16 of the farm Bloemendal 283 IR, Portion 3 and the Remaining Extent of the farm Rietfontein 276 IR, Portions 4, 5, 9, 12, 22, 28 and the Remaining Extent of the farm Nooitgedacht 286 IR, Portions 1, 2 and the Remaining Extent of the farm Potfontein 285 IR, and Portions 2 and 7 of the farm

Vlakfontein 281 IR. The site is located 13 km south-east of Springs and 13.73 km north-east of Nigel, in both the Springs and Nigel Magisterial Districts, Sedibeng District Municipality and Lesedi Local Municipality, Gauteng Province. The agricultural holdings of Endicott and Vischkuil are located immediately north of the study area. The N17, R42 and the R550 run through the study area. The Mining Right application area can be located within the confines of 1:50 000 topographic map 2628BC. The aerial extent of the Mining Right application area is 11 166 ha.

The complete extent of the Mining Right application area entails a life-of-mine of more than 50 years and covers the above-mentioned farm portions. However, the environmental authorisation (EA) application for which this report is required is only applicable to the first phase of the project. Phase one of the mining operation has an estimated life-of-mine of approximately nineteen years. Accordingly, only Portions 6, 9, 10, and 11 of the farm Bloemendal 283 IR and the Remaining Extent of the farm Rietfontein 276 IR will be applicable for this environmental authorisation (EA) application. The nature and extent of the mining operations and the details and location of the associated infrastructure is only described, herein for, Phase one of the proposed mining operations; this is the area covered by the current environmental authorisation application. These details may well be different in subsequent phases of the life of mine. Accordingly, the findings of this report are valid only for the area covered by the current environmental authorisation application.

The aerial extent of the Mining Right application area is underlain by a lithologically diverse assemblage of stratigraphic units consisting of Swazian (Archaean) granite- gneiss of the Johannesburg Dome, predominantly siliciclastic sediments of the Hospital Hill Subgroup (and probably also the Government Subgroup), carbonate sediments of the Malmani Group, glaciogene sediments of the Dwyka Group, coal-bearing sediments of the Vryheid Formation and intrusive dolorite of the Karoo Dolorite Suite. It is interpreted that Cainozoic regolith forms the land surface over the majority of the Mining Right application area.

Due to the methodologies employed in the mining process and also the extreme costs of mining no negative impact upon the geological sequence will be expected to occur below the base of Seam 2 as the mine voids will not extend deeper than that. The maximum depth of this impact is unknown (but will probably be on the scale of 10’s of meters). What is significant, however, is that the negative impacts will be constrained to the Vryheid Formation and any overlaying geological units.

The required mine infrastructure, other than the two planned opencast pits, will all be located on the land surface. Of the non-opencast pit infrastructure, the excavations required for the foundations for offices, a weighbridge, stormwater trenches and trenches to provide power and water access will result in the deepest impact upon the underlying geology. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 2 m.

The rocks comprising the Swazian granite-gneiss, Hospital Hill Subgroup, Government Subgroup, and the Karoo Dolerite Suite are unfossiliferous. It is also interpreted, herein, that the interpreted Cainozoic regolith is unfossiliferous. Any impacts upon the rocks comprising these units caused by the progression of the mining operations will have a **negligible to nil** probability of resulting in a negative impact upon their palaeontological heritage. The carbonate sediments of the Malmani Group are fossiliferous, and are known to contain prolific stromatolite assemblages. The probability of any significance of any negative impact upon the palaeontological heritage of the Malmani Group is assessed high, but the significance is **low**. The sediments of the Vryheid Formation and the Dwyka Formation are known to contain plant macrofossil assemblages of the *Glossopteris* flora (the former also containing trace fossil assemblages). The significance of the fossil assemblages contained in these two units was assessed as **high**, but the probability of any negative impact is **moderate to good** for the Vryheid Formation and **low** for the Dwyka Group.

It is evident that the proposed mining operations pose a significant risk of negatively impacting upon scientifically highly significant fossil assemblages and damage mitigation protocols are required. Accordingly, it is recommended that:

- A thorough field investigation be conducted by an appropriately experienced Karoo palaeontologist prior to the commencement of the project in the area identified in the current environmental authorisation application and a Full Palaeontological Impact assessment report be submitted to SAHRA.
- This would allow a meaningful evaluation of the presence of fossil materials being present at surface.
- If fossil materials prove to be present the process would allow the identification of any scientifically significant fossils and allow resultant recommendations that they should be either be protected completely, *in situ,* or could have damage mitigation procedures emplaced (i.e., excavation by a suitability by a suitably experienced palaeontologist) to minimise negative impacts.

It was identified above (see Section 9.1) that the disruption of the geological strata underlying the project area will result in the complete and permanent disaggregation and destruction of the geological strata from the land surface to the complete depth of the in the mine voids. This in effect means that in the two areas identified for opencast mining The Vryheid Formation will be completely destroyed down to the base of Seam 2.

It is recommended that once excavation of the pit voids begins:

- On-site checks for the occurrence of any fossils of the excavated pits and stockpiled material should be conducted every six months by an appropriately experienced Karoo palaeontologist.
- The frequency of these checks should be assessed after six months based on the findings and the planned mining programme.
- The Karoo palaeobotanist should submit a monitoring report to SAHRA on this work.

In addition,

- Should any fossil materials be identified, the palaeontologist should ascertain their scientific and cultural importance.
- Should the fossil prove scientifically or culturally significant the particular excavations involved should be halted and SAHRA informed of the discovery (as required in Section 3.3 above).
- Should scientifically or culturally significant fossil material exist within the project areas 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 could be protected and the site of any planned construction moved.

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 could be protected and the site of any planned construction moved.

This desktop study has not identified any palaeontological reason to prejudice the progression of this project subject to the recommended damage mitigation protocols outlined above being instituted.

13 REFERENCES

Anderson, A.M. and McLauchlan, I.R. (1976). The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the Great Karoo Basin, South Africa. *Palaeontologia Africana*, 19: 31-42.

Anderson, J.M. (1977). The biostratigraphy of the Permian and Triassic. Part 3. A review of Gondwana Permian palynology with particular reference to the northern Karroo Basin of South Africa. *Memoirs of the Botanical Survey of South Africa*, 41: 1–133.

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

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.

Eriksson, P.G., Altermann, W., and Hartzer, F.J. (2006)., *The Transvaal Supergroup and its precursors* in Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (eds) *Geology of South Africa*, Johannesburg: Council for Geoscience, Pretoria: Geological Society of South Africa, pp. 237-260.

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: 461–499.

Jubb, R.A. and Gardiner, B.G., (1975). A preliminary catalogue of identifiable fossil fish material from southern Africa. *Annals of the South African Museum*, 67 (11): 381–440.

Hobday, D.K. and Taverner-Smith, R. (1975). Trace fossils in the Ecca of northern Natal and their palaeoenvironmental significance. *Palaeontologia Africana*, 18: 47-52.

McCarthy, T.S. (2006). *The Witwatersrand 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: 155–186.

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

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.

Robb, L.J., Brandle, G., Anhaeusser, C.R. and Poujol, M. (2006). *Archaean granitoid intrusions*, 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: 57–94.

Tavener-Smith, R., Cooper, J.A.G. and Rayner, R.J. (1988). Depositional environments in the Volksrust Formation (Permian) in the Mhlatuze River, Zululand. *South African Journal of Geology,* 91: 198-206.

Dr B.D. Millsteed

12th August 2018