FULL PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF RAUBEX CONSTRUCTION (PTY) LTD'S PROPOSED AGGREGATE MINE TO BE LOCATED ON PORTION 3 AND PORTION 30 OF BOSCHMANSPOORT 159, APPROXIMATELY 15 KM NORTH OF HENDRINA, MPUMALANGA PROVINCE

10 August 2015

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On behalf of:

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On Behalf of:

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Prepared By:

Prof B.D. Millsteed

EXECUTIVE SUMMARY

Raubex Construction (Pty) Ltd intends to apply for a Mining Permit to mine 4.9 ha of a portion of Portion 3 and Portion 30 of the farm Boschmanspoort 159 with the aim of extracting aggregate. The site is located approximately 15 km north of Hendrina, 51 km south-east of Emalahleni and approximately 2.5 km north of the Klein Oliphants River, Middelburg Magisterial District, Mpumalanga Province. The aggregate / stone gravel removed from the quarry will be used for road construction in the vicinity.

Raubex Construction (Pty) Ltd has appointed Greenmined Environmental (Pty) Ltd to undertake an Environmental Impact Assessment of the proposed project and the subsequent production of Environmental Management Programs (EMPr) for the project. Greenmined Environmental (Pty) Ltd has contracted Heritage Contracts Archaeological Consulting CC, as independent consultants, to undertake a Heritage Impact Assessment to identify and assess all potential environmental impacts associated with the proposed project for the area as identified and propose appropriate mitigation measures in an Environmental Management Programme ("EMP"). Heritage Contracts Archaeological Consulting CC has appointed BM Geological Services to provide a Full Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

A Full Palaeontological Impact Assessment Study has been conducted on the location of the site of Raubex Construction (Pty) Ltd's proposed aggregate mine by Prof B.D. Millsteed on the 5th of August 2015. No fossil materials were identified within the project area. The surface of the project area is formed by unfossiliferous medium- to coarse-grained sandy regolith. A relatively thin sequence of sandstones belonging to the Permian Vryheid Formation underlie the regolith and this unit is known to contain scientifically significant fossils elsewhere in its extent. The volcanic rocks of the Palaeoproterozoic Rooiberg Group appear to be present beneath the entire project area, but are unfossiliferous.

The 4.9 ha extent of the proposed project is relatively small. 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 local.

The effects of the required construction operations to the geological strata underlying the project areas will be restricted to the Early Permian Vryheid Formation. The probability of any of the projects resulting in a negative impact on the palaeontological heritage of the Vryheid Formation has been assessed as moderate. Any negative impact on the fossil materials will potentially be highly significant due to the scientific and cultural

importance of many of the fossils that may be expected to be present. However, the social benefits of the projects have been classified as beneficial, herein, as the projects aim to provide aggregate that will be used for road construction in the vicinity. The proposed quarry will therefore contribute to the upgrading/maintenance of road infrastructure in and around the Hendrina and Middelburg area. The following damage mitigation protocols are accordingly recommended:

- The proposed excavations should be inspected at a regular interval by a palaeontologist when and where they intersecting the Vryheid Formation.
- 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.
- 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 will be made available for scientific study.

The implementation of these protocols will minimise the potential negative impact of the projects and ensure that the severity/benefit scale for the projects is beneficial.

This study has not identified any palaeontological reason to prejudice the progression of either the Raubex Construction (Pty) Ltd's aggregate mine, subject to the recommended damage mitigation procedures being enacted.

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Raubex Construction (Pty) Ltd intends to apply for a Mining Permit to mine 4.9 ha of a portion of Portion 3 and Portion 30 of the farm Boschmanspoort 159 with the aim of extracting aggregate. The site is located approximately 15 km north of Hendrina, 51 km south-east of Emalahleni and approximately 2.5 km north of the Klein Oliphants River, Middelburg Magisterial District, Mpumalanga Province (Figure 1). The corner points of the project area are provided in Table 1. The aggregate / stone gravel to be removed from the quarry will be used for road construction in the vicinity.

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2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Identify all palaeontological materials located in the area to be affected by the proposed new construction activities.
- Quantify the palaeontological heritage significance of any fossil materials identified.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Propose suitable mitigation measures to minimise possible negative impacts, if any are identified, on the palaeontological heritage of the site.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

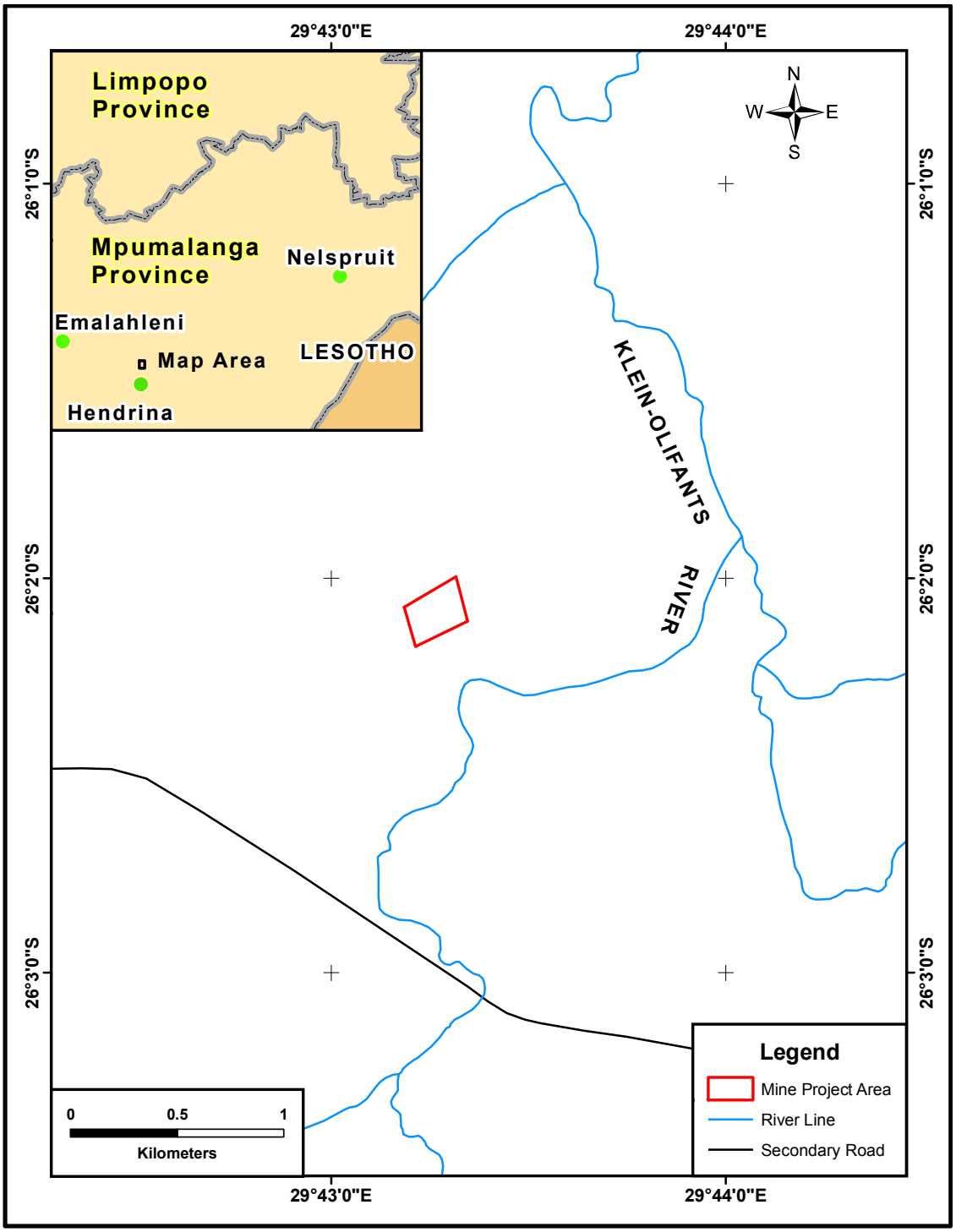

Figure 1: Location map showing the position of the proposed Aggregate Mining Project

Table 1: Corner point co-ordinates for the project. The co-ordinates are supplied in geographic format.

POINT	LATITUDE	LONGITUDE
A	-26.034561	29.719736
B	-26.036222	29.720228
C	-26.035153	29.722422
D	-26.033264	29.721933

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

Prof 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 the Geological Society of South Africa.

5 METHODOLOGY

The study area was visited on the 5th August 2015 by Prof B.D. Millsteed. The site of the proposed mining area was comprehensively traversed by a foot. The paths of the various traverses were recorded as a series of trackways on a hand-held GPS and their locations are indicated in Figure 2. Photographs were taken and detailed observations made were taken at a number of locations (see data waypoint locations in Figure 3). The location of the photographs and detailed observation points was recorded using a hand-held GPS.

6 ACCESS AND INDEPENDENCE

The area to be impacted by the construction of the proposed mine was supplied to BM Geological Services as series of corner points (Table 1). The site visit was conducted completely free of any hindrance. Access was freely available to those portions of the study area and the field visit was able to be conducted wherever required. Similarly, within the study area there were no topographic or environmental features associated

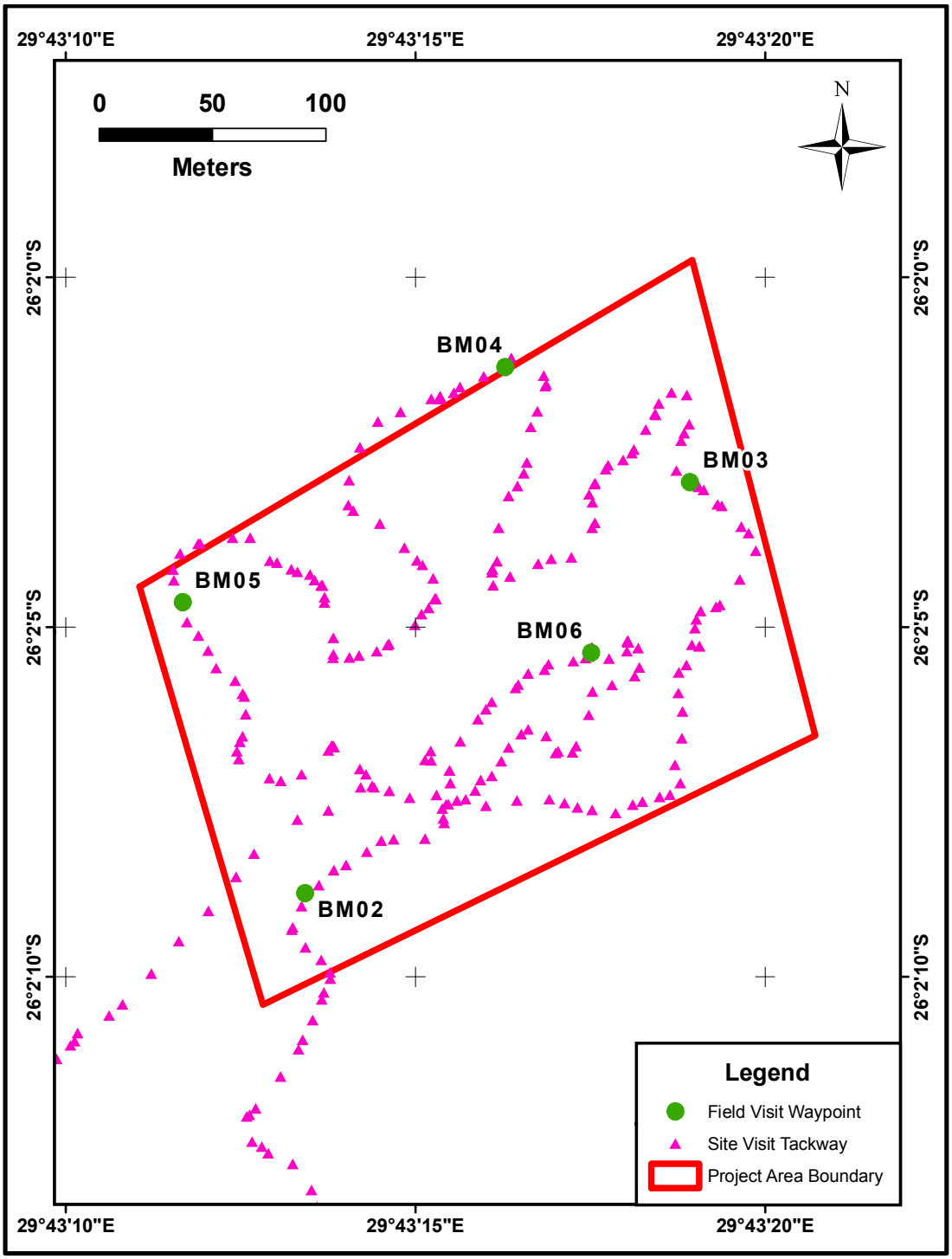

Figure 2: Map showing the location of the proposed mining area, the GPS trackway representing the location of the foot traverse of the area and the location of waypoints at which data was collected.

with the study area which made physical inspection impossible or unduly difficult. Accordingly, there were no areas that could not be easily visited and studied.

Prof 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 Prof Millsteed nor BM Geological Services has any financial interest in either Raubex Construction (Pty) Ltd or the proposed mine.

7 GEOLOGY AND FOSSIL POTENTIAL

The mining project is located within the extensive coal mining region of Mpumalanga. Figure 3 shows that the proposed mining area is located immediately to the north of Palaeoproterozoic volcanic rocks of the Rooiberg Group. The map suggests that the mining area is underlain by Permian sediments of the Vryheid Formation. The rocks of this unit are extensively exploited for coal in the region. A summary of the characteristics of the various geological strata underlying the project area and their fossiliferous potential follows.

7.1 Rooiberg Group

7.1.1 Geology

The predominantly volcanic rocks of the Rooiberg Group form part of the Bushveld Complex (Buchanan, 2006). Isotopic ages obtained from the rocks of the Rooiberg Group range from 2061 ± 2 Ma to 2053 ± 48 Ma (Walraven, 1997; Walraven *et al*., 1987, 1990). The sequence consists of thick (up to 400 m) units of volcanic rocks (Harmer and von Gruenewaldt, 1991) interspersed with interbedded, thin laterally sedimentary strata (Eriksson *et al*., 1994). The group has been subdivided into four formations, these being the Dullstroom, Damwall, Kwaggasneck and Schrikkloof Formations (Figure 4).

The Dullstroom Formation forms the base of the sequence and is composed predominantly of mafic to intermediate volcanic ranging in composition from basalts to dacites. The Damwall Formation consist of massive, amygdaloidal dacites and rhyolites interbedded with quartzite and pyroclastic flows, The Kwaggasnek Formation consists of rhyolites which are locally flowed-banded near the top of the unit and which also contains quartzite xenoliths. Near the top of the Kwaggasnek Formation occurs a thick units of agglomerates and shale tuff that collectively constitute the Union Tin Member. The upper-most formation that comprises the Rooiberg Group is the Schrikkloof Formation and it comprises of >1000 m of predominantly flow-banded rhyolite containing occasional quartzite lenses and xenoliths (Buchanan, 2006).

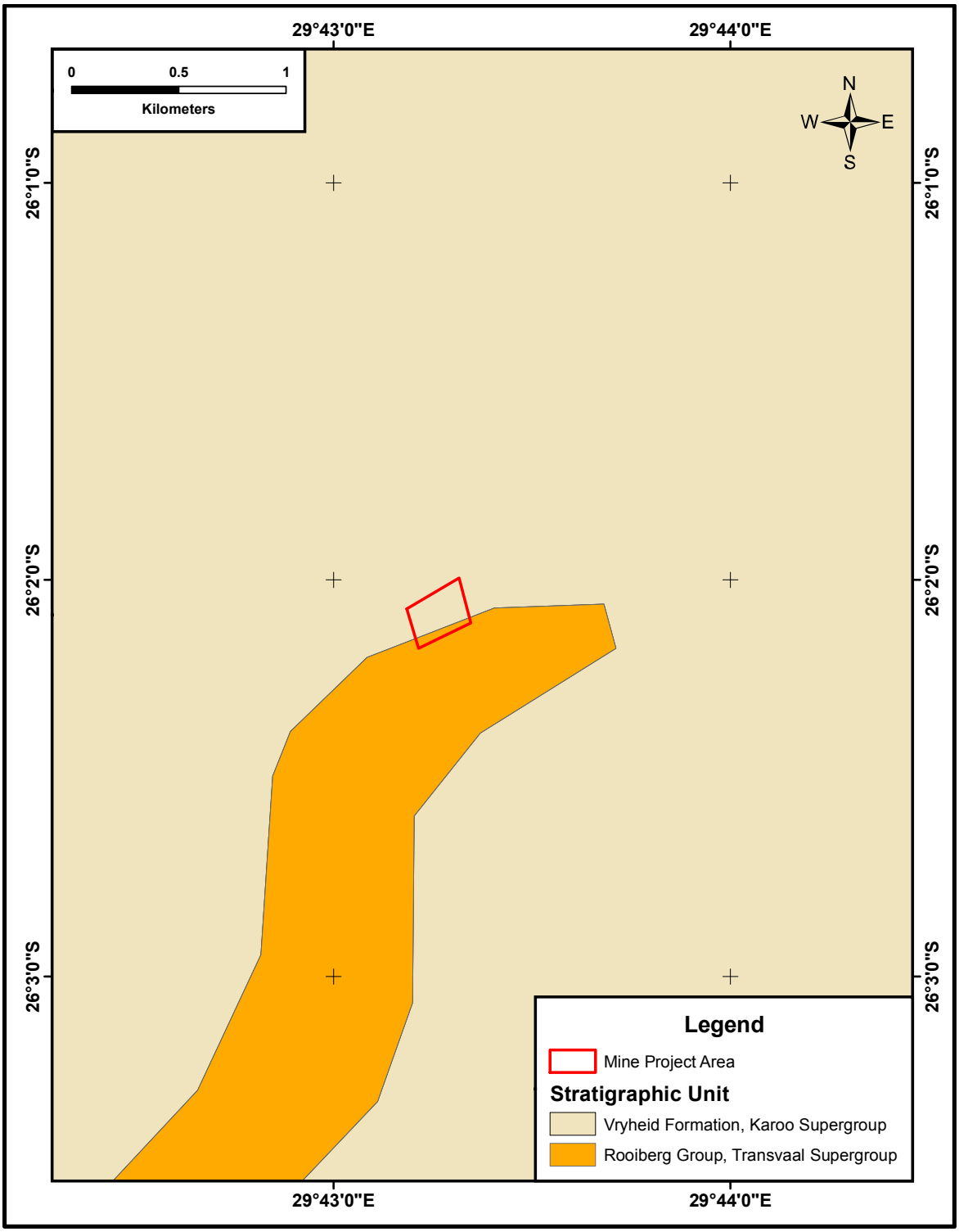

Figure 3: Geological map of the geological units underlying the proposed mining project area and its immediate environs.

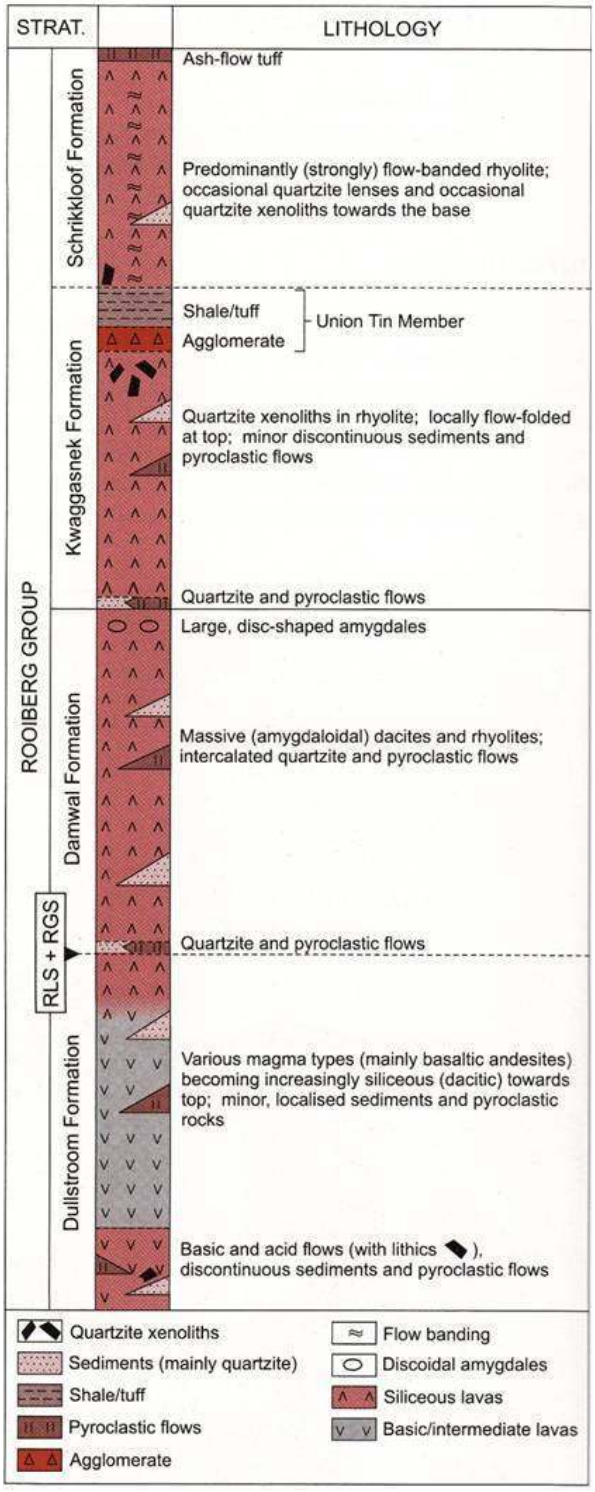

Figure 4: Generalised stratigraphic column of the Rooiberg Group (Buchanan, 2006).

The rocks of the Rooiberg Group were not observed to crop out within the project area. However, a historic quarry pit exists immediately next to the project area (Figure 5) and all strata exposed here belong to the Rooiberg Group. The rocks consist of pink coloured, medium-grained rocks exhibiting igneous textures (Figures 6). It was evident that the entire high wall of the quarry (located immediately proximally to the boundary of the project area) was composed of the Rooiberg Group. Given the high of the high wall it appears probable that the strata extend under the entire extent of the project area (Figure 7).

7.1.2 Palaeontological potential

Given the volcanic origin of the strata comprising the Rooiberg Group it is to be expected that they should not contain fossils. Indeed, a detailed investigation of the rocks comprising the Rooiberg Group was made where they are exposed in the historic mine quarry; no palaeontological materials were observed in the strata. The unit is accordingly considered to be unfossiliferous.

7.2 Vryheid Formation

7.2.1 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 8). 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 8).

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).

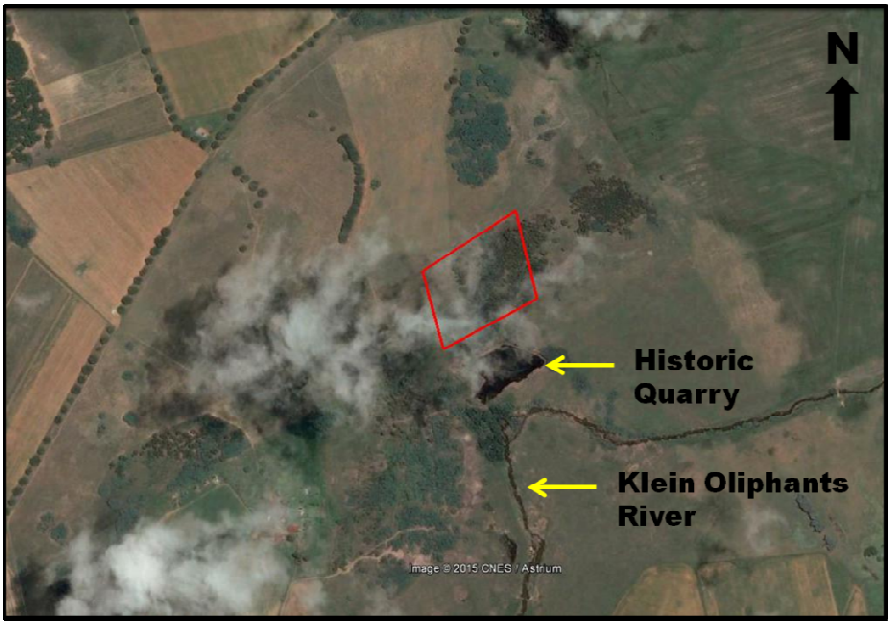

Figure 5: Google earth image of the location of the proposed mining operation (red polygon). Located immediately to the south of the project area is a historically mined quarry pit. The Klein Oliphants River lies to the south of the historical quarry pit.

Figure 6: Pink, medium grained igneous rock of the Rooiberg Group cropping out at the historical quarry (Waypoint BM01, see Figure 2).

Figure 7: View from the southern margin of the historical mine quarry looking towards the north. The rocks forming the pit walls are compose of the pink, medium-grained igneous rock shown in Figure 6. The mine wall in the background is immediately adjacent to the southern border of the proposed mining area. It is evident that the rocks of the Rooiberg Group should extend northwards and be present beneath the mining area (Waypoint BM01, see Figure 2).

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.

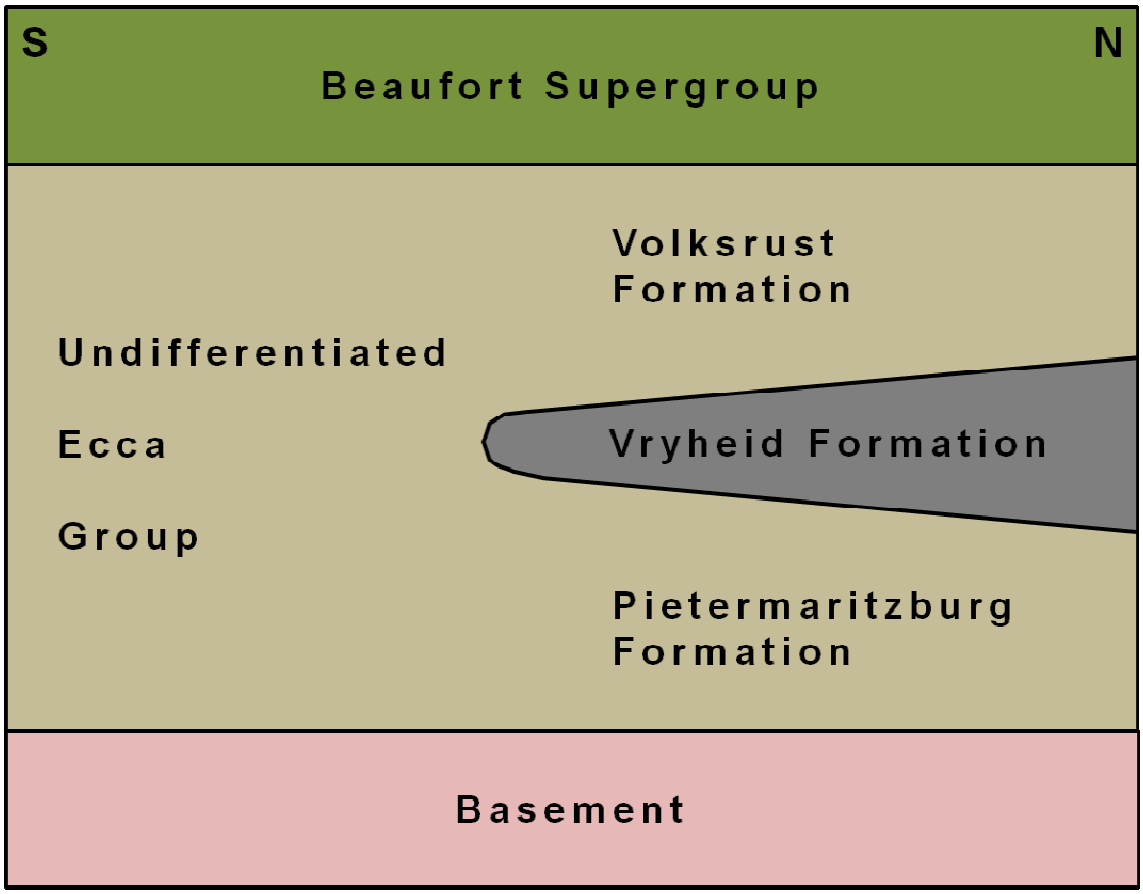

Figure 8: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

It is evident from Figure 2 that rocks of the Vryheid Formation underlie the majority of the area surrounding the project area. The Vryheid Formation stratigraphically overlies the Rooiberg Group and it is to be expected that they will thin and pinch out completely where they abut the outcrop of the Rooiberg Group. A number of small, low outcrops of grey Vryheid Formation sandstones were identified (Figure 9) in the central portion of the project area during the site investigation. It is thus likely that much of the project area is underlain by a thin veneer of Vryheid sandstones which in turn overlie the Rooiberg Group.

Figure 9: Low outcrop of Vryheid Formation sandstone present within the project area (Waypoint BM06, see Figure 2).

7.2.2 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.

8 ENVIRONMENT OF THE PROPOSED PROJECT SITES

The area for the proposed aggregate mine is relatively small; being approximately 4.9 ha. Examination of Google earth imagery (Figure 5) indicates that the project area and the surrounding environs is located within a region dominated by agricultural cultivation, but with a historical, but inactive active mine quarry pit located immediately to the south of the project area. The project area itself appears to be thickly vegetated with tress. The site visit verified this observation and confirms that thick plantations of *Eucalyptus* trees are present (Figure 10), although they are currently being cleared. The soils present within the project area are uniformly medium- to coarse-grained, orange-red sandy soils (Figure 11).

The natural vegetation cover of the project area consists of the Eastern Highveld Grassland vegetation type (Figure 12). The conservation status of the Eastern Highveld Grassland is described by Mucina and Rutherford (2006) as endangered. However, due to the extensive cover of *Eucalyptus* trees (Figure 10) over much of the project area it was apparent during the site visit that significant areas of the original vegetation remains extant within the project area (Figures 13 and 14).

It is evident from Figure 15 that the project area lays on the eastern slope of a low, elongate north-south oriented ridge and approximately 250 m north of the Klein Oliphants River. Otherwise, apart from the historical mine quarry located immediately to the south of the project area the environs are topographically undulating and featureless No significant fluvial drainage lines traverse the project area.

Figure 10: View of dense growth of *Eucalyptus* trees present within portions of the project area (see Waypoint BM03, Figure 2).

Figure 11: Coarse-grained, orange-red coloured sandy soil of this type underlies the entire project area.

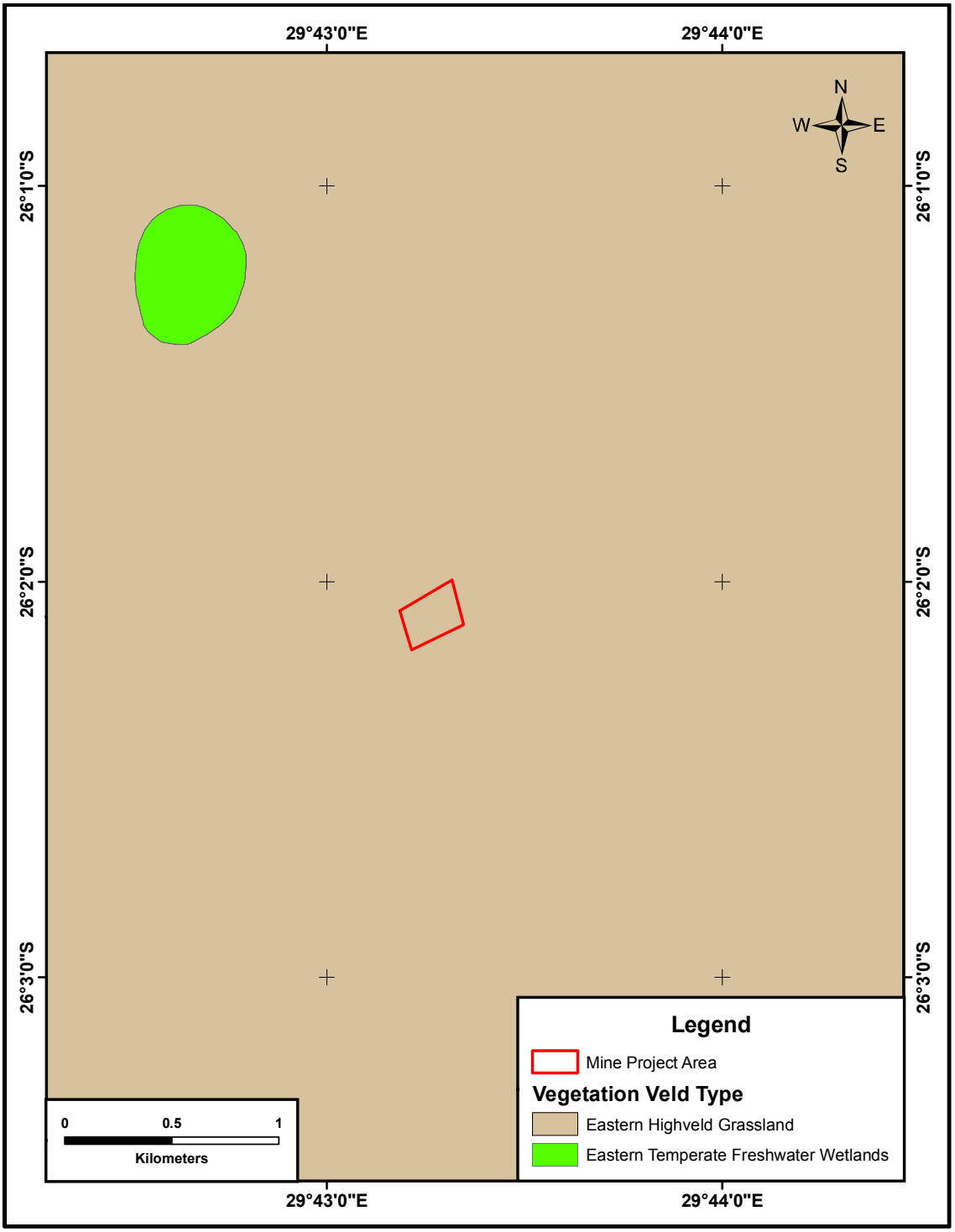

Figure 12: Map of the vegetation veld types underlying the project area and its immediate environs (after from Mucina and Rutherford, 2006)

Figure 13: View to the south of the grassland vegetation present within the project area (see Waypoint BM02, Figure 2).

Figure 14: View to the south of the grassland vegetation present within the project area (see Waypoint BM05, Figure 2).

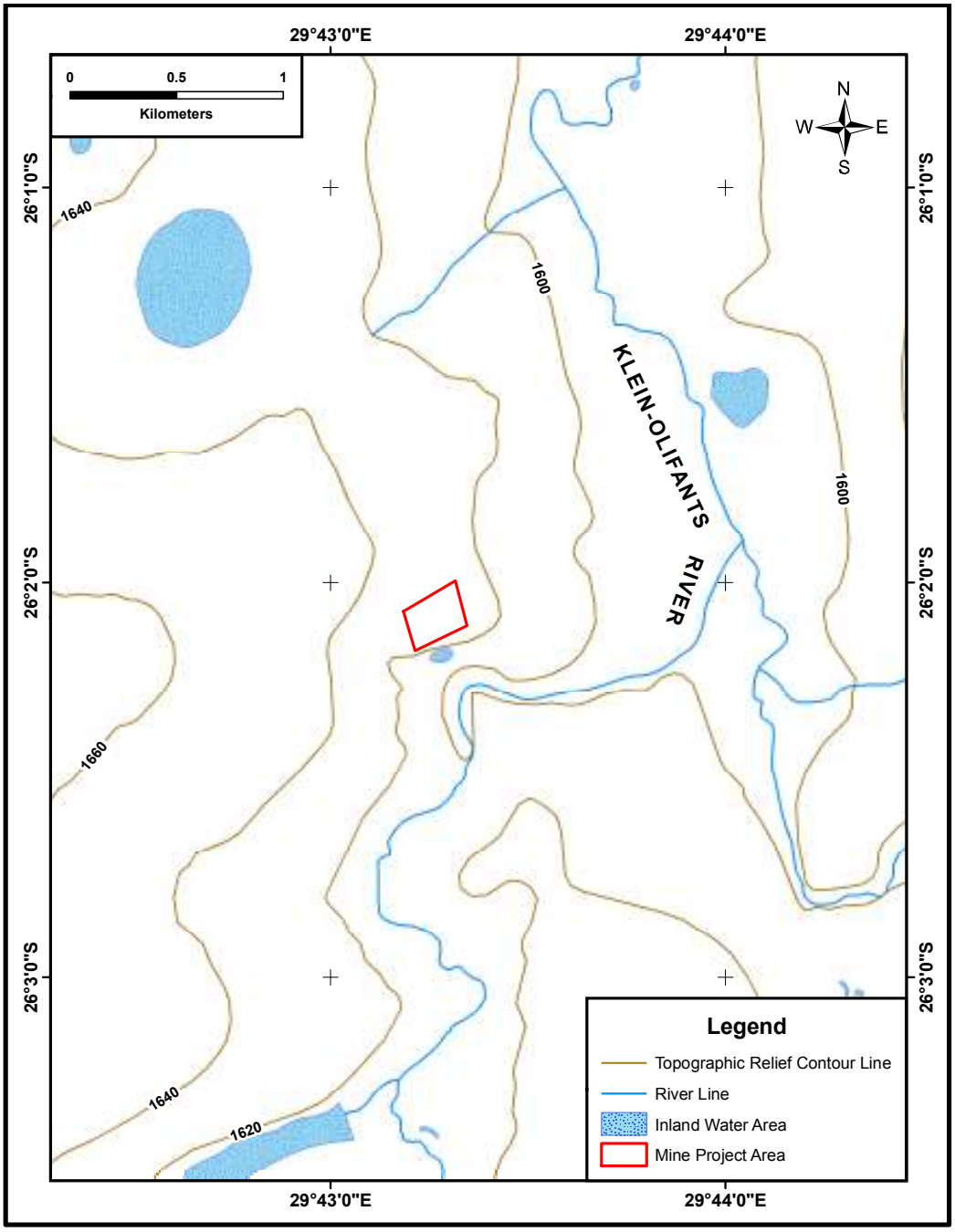

Figure 15: Map of the project area and its immediate environs. The project area lies upon the eastern slopes of a low, elongate north-south oriented ridge. A historic mine quarry pit lies immediately to the southern border of the project area. The Klein Oliphants River is flows close to the south of the quarry pit, but no significant fluvial systems traverse the any of the project area. The topographic contour interval is 20 m.

9 OVERVIEW OF SCOPE OF THE PROJECTS

The proposed aggregate mining site will be an extension of an existing but non-operating aggregate quarry pit. The mining methods will make use of blasting by means of explosives in order to loosen the hard rock. The loosened rock material will then be loaded and hauled out of the quarry pit to mobile crushing and screening plants. The crushed aggregate will be stockpiled and transported to clients via trucks and trailers. All activities will be contained within the boundaries of the site. The current projected life of mine is expected to be for at least three years with a possibility of a two year extension.

The mining activities will consist of the following activities:

- Stripping and stockpiling of topsoil
- Blasting
- Excavating
- Crushing
- Stockpiling and transporting
- Sloping and landscaping upon closure of the site
- Replacing the topsoil and vegetating the disturbed area

The following mining plant will be utilised:

- Mobile crushing equipment
- Mobile screening equipment
- Drilling equipment
- Excavating equipment
- Earth moving equipment

9.1 Effect of projects on the geology

The planned maximum depth of mining is unknown to the author at the time of preparation of this report. However, it is a given that the regolith overlying all areas to be mined will be completely disturbed and negatively impacted. Similarly, the rocks of the Rooiberg Group (that are the mining target lithology) owing to the disaggregation and removal of the rock for sale the strata will be completely and permanently negatively impacted. It is not likely that the proposed mining operations will proceed to levels lower than the base of the Rooiberg Group strata as they have no commercial value for aggregate.

10 IMPACT ASSESSMENT

The potential impact of the proposed aggregate mining operation is categorised below according to the criteria outlined below.

10.1 Nature of impact

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

- Damage or destruction of fossil materials during the construction of projects 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.

10.2 Extent of impact

The possible extent of the permanent impact of the proposed projects 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 projects. 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 projects. The **extent of the area of potential impact is, accordingly, categorised as local** (i.e., restricted to the project site).

10.3 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 mine will be unavailable for scientific study for the life of

the existence of those features. However, the life-of-mine is planned to be < 5 years and no permanent infrastructure is planned.

10.4 Probability of impact

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 Volksrust 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 and despite the fact that no fossil materials were identified during the site visit the probability of a negative impact is accordingly assessed as being **moderate**. The volcanic rocks of the Rooiberg Group are unfossiliferous, and accordingly the probability of the project resulting in any negative impact upon them is **nil**.

10.5 Significance of the impact

Should the proposed projects progress without due care to the possibility of fossils being present within the Vryheid Formation the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. The potential for negative impact is accentuated by the fact that often the plant macrofossils and trace fossils that are known to be present in this formation often occur in dense accumulations, and as such, if any negative impact occurs it may well affect many fossils simultaneously. 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 rocks of the Rooiberg Group are unfossiliferous. Accordingly, no fossil materials will be negatively impacted upon within the unit because of the mining operations. The significance of any negative impact upon the palaeontological heritage of the unit will be **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.

10.6 Severity / benefit scale

The proposed projects are categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide aggregate be used for road construction in the vicinity. The proposed quarry will therefore contribute to the upgrading/maintenance of road infrastructure in and around the Hendrina and Middelburg area.

The probability of a negative impact on the palaeontological heritage of the project areas has been categorised as moderate for the Vryheid Formation and nil for the Rooiberg Group. However, the implementation of suitable damage mitigation and avoidance protocols, as outlined below, will minimise the probability of any negative impact occurring.

10.7 Status

The proposed projects would provide aggregate that will be used for road construction in the vicinity. The proposed quarry will therefore contribute to the upgrading/maintenance of road infrastructure in and around the Hendrina and Middelburg area. As such, the project is determined as having a **positive status** herein.

11 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

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

11.1 Mitigation

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 void. The volcanic rocks of the Rooiberg Group are unfossiliferous, so no damage mitigation procedures are required when the unit is being mined. No fossil materials were identified in the Vryheid Formation during the site inspection but the unit is known to be fossiliferous elsewhere in its extent. There is a possibility that the disruption of this unit by the mining operations may result in a significant negative impact on the palaeontological heritage of the project area.

The following damage mitigation protocols are recommended for the proposed mining operation:

- The proposed excavations should be inspected at a regular intervals by a palaeontologist when and where and if they intersect the Vryheid Formation.
- 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.
- 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 will be made available for scientific study.

11.2 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**.

11.3 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.

12 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a detailed site investigation conducted on foot. No fossil materials were observed during the conduct of that survey. However, the potentially fossiliferous Vryheid Formation is present within the area to be mined. There is an absence of bedrock outcrop over almost the entire extent of the site with most of the area covered by sandy regolith. Accordingly, the fossiliferous potential of the Vryheid Formation within the study area could not be comprehensively ascertained. The presence of fossils within the subsurface levels of this unit within the project area remains a possibility.

13 ENVIRONMENTAL IMPACT STATEMENT

A Full Palaeontological Impact Assessment Study has been conducted on the location of the site of Raubex Construction (Pty) Ltd's proposed aggregate mine. The proposed project area is relatively small with an aerial extent of 4.9 ha. 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 local.

The effects of the required construction operations to the geological strata underlying the project areas will be restricted to the Early Permian Vryheid Formation; this geological unit is known to be fossiliferous. The probability of any of the projects resulting in a

negative impact on the palaeontological heritage of the Vryheid Formation is assessed as being moderate. Any negative impact on the fossil materials will potentially be highly significant due to the scientific and cultural importance of many of the fossils that may be expected to be present. However, the social benefits of the projects have been classified as beneficial, herein, as the projects aim to provide aggregate that will be used for road construction in the vicinity. The proposed quarry will therefore contribute to the upgrading/maintenance of road infrastructure in and around the Hendrina and Middelburg area. The following damage mitigation protocols are accordingly recommended:

- The proposed excavations should be inspected at a regular interval by a palaeontologist when and where and if they intersect the Vryheid Formation.
- 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.
- 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.

The implementation of these protocols will minimise the potential negative impact of the projects and ensure that the severity/benefit scale for the projects is beneficial.

This study has not identified any palaeontological reason to prejudice the progression of either the Raubex Construction (Pty) Ltd's aggregate mine, subject to the recommended damage mitigation procedures being enacted.

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