DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF SUBIFLEX (PTY) LTD'S PROPOSED COAL MINE TO BE LOCATED ON THE FARMS LOTSIEUS 176 MT, KRANSPOORT 180 MT, NAIROBI 181 MT AND THE DUEL 186 MT, APPROXIMATELY 54 KM NORTH OF MAKHADO, LIMPOPO PROVINCE

20 August 2015

Prepared for:
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Prepared for:

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Prepared By:

Prof B.D. Millsteed

EXECUTIVE SUMMARY

Subiflex (Pty) Ltd holds a Prospecting Right on the farms Lotsieus 176 MT, Kranspoort 180 MT, Nairobi 181 MT and The Duel 186 MT and is proposing to develop an underground and opencast coal mine with a potential Life-of-Mine of 24 years.

The proposed mine development is located 54 km north of Makhado (previously Louis Trichardt), 20 km southwest of Tshispese and 9 km northeast of Fripp in the Makhado Local Municipal area, Soutpansberg Magisterial. The site of the proposed mining operation occupies and area of approximately 889 ha.

Subiflex (Pty) Ltd has appointed Jacana Environmentals cc to undertake an Environmental Impact Assessment of the proposed project and the subsequent production of Environmental Management Programs (EMPr) for the project. A portion of the proposed project area falls within the RED category of SAHRA's Palaeontological Sensitivity Map; thus, a a palaeontological assessment is required Jacana Environmentals cc has accordingly contracted BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

The project area is variously underlain by strata belonging to the underlain by strata of the Sibasa, Wyllies Poort and Nzhelele Formations (Palaeoproterozoic Soutpansberg Group); the Tshidizi, Madzaringwe, Mikambeni, Fripp, Solitude and Clarens Formations (Palaeozoic Karoo Supergroup).

The rocks of the Palaeoproterozoic Soutpansberg Group are unfossiliferous and any development associated with the project that occurs upon exposures will result in nil negative impact upon the palaeontological heritage. The open cast mining operations will target the Madzaringwe Formation, but the overlying Mikambeni and Fripp Formations will need to be stripped to expose the coal-bearing Madzarinwe Formation. During the underground mining phase only the Madzaringwe Formation will be directly affected by the mining activities. While no fossil materials are expected to be located within the coals they may be expected to be present within siliciclastic partings within the coal seams. The Clarens and Solitude Formations will not be targeted by the mining operations, but almost the entire superficial portions of both units will be negatively impacted by the construction of mine infrastructure.

The potential for a negative impact upon the palaeontological heritage of the coal-bearing strata of the Ecca Group (the Madzaringwe and Mikambeni Formations) is assessed as moderate; that of the underlying Tshidizi Formation is assessed as being low. However, all three formations are expected to contain highly scientifically significant plant macrofossils of the *Glossopteris* flora. Any negative impact upon these

fossil floras would result in a high negative impact. The probability of such a negative impact is elevated by the fact that both the Madzaringwe and Mikambeni Formations will be targeted during the open cast mining phase and the Madzaringwe Formation will be targeted during the underground mining phase.

The fossil potential of the Triassic Fripp Formation is assessed as being low, but it is known to contain plant macrofossils belonging to the highly scientifically significance *Dicroidium* flora. Accordingly, any negative impact caused by the mining operations would be of high significance. This unit will not be targeted during the mining operations and, as a result, the construction of infrastructure elements on this unit will result in negative impacts being restricted to the upper-most 1-2 m of the land surface.

The Solitude and Clarens Formations are known to be fossiliferous and to contain diverse vertebrate fossil faunas. However, vertebrate fossils are usually sparsely distributed and relatively uncommon. As such, the probability of a negative impact upon these fossil faunas has been assessed as low; yet the vertebrate faunas are of the highest scientific significance and any negative impacts would be highly significant.

The potential negative impacts of the project must be balanced against the fact that the proposed mining project aims to provide coal for the production and supply of electricity to an increasingly strained national power grid. The project is assessed as being beneficial and having a positive status should the the negative impacts of the project being mitigated to the maximum practical extent. The following damage mitigation protocols are recommended:

- A thorough examination by a palaeontologist is required on the exposures of the Karoo Supergroup strata present within the project area (i.e., a Full Palaeontological Impact Assessment Study on these exposures) before the commencement of the project. This would allow a meaningful evaluation of the presence of potentially fossiliferous strata within that area. If fossil materials prove to be present the process would allow the identification of any such fossils that should either be protected completely or could have damage mitigation procedures emplaced to minimise negative impacts.
- Should any fossil materials be identified SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance as part of a Phase 2 Palaeontological Impact Investigation study.
- A significant potential benefit of the examination of the mine excavations associated with the construction of the projects is that currently unobservable fossils may be uncovered.
- Suitable staff members of the mining company (e.g., the environmental officer) who have the correct training and clearance to access the working mine faces

should be trained to recognise the types of fossils that may be encountered during the ongoing mining operations. It is unlikely that plant macrofossils will be encountered in the coal seam(s), but may well be encountered in the hanging and foot walls as well as in any siliciclastic partings contained within the coal (and that will be exposed on the working mine face).

- The mining company should mandate the trained employees to make regular examinations of the working mine faces and determined if fossil materials are present. The interval between inspections will be dependent upon the rate of progress of the mining activities, but should not be conducted on less than a monthly basis.
- If fossil materials are identified, the infrastructure construction or the mining activity in that area should be temporarily halted and a professional palaeontologist contracted to assess the scientific value of the fossils.
- Should scientifically or culturally significant fossil material exist within the project areas the negative impact upon it would be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution.

This desktop study has not identified any palaeontological reason to prejudice the progression of the proposed mining operations subject to the recommended damage mitigation procedures being enacted.

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Subiflex (Pty) Ltd has appointed Jacana Environmentals cc to undertake an Environmental Impact Assessment of the proposed project and the subsequent production of Environmental Management Programs (EMPr) for the project. A portion of the proposed project area falls within the RED category of SAHRA's Palaeontological Sensitivity Map; thus, a palaeontological assessment is required Jacana Environmentals cc has accordingly contracted BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Conduct a desktop assessment of the potential impact of the proposed project areas on the palaeontological heritage of each of the project areas.
- 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.

POINT	LATITUDE	LONGITUDE
A	-22.730042	30.015767
B	-22.724998	30.027281
C	-22.752736	30.050473
D	-22.775775	30.042961
E	-22.758274	30.029282

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

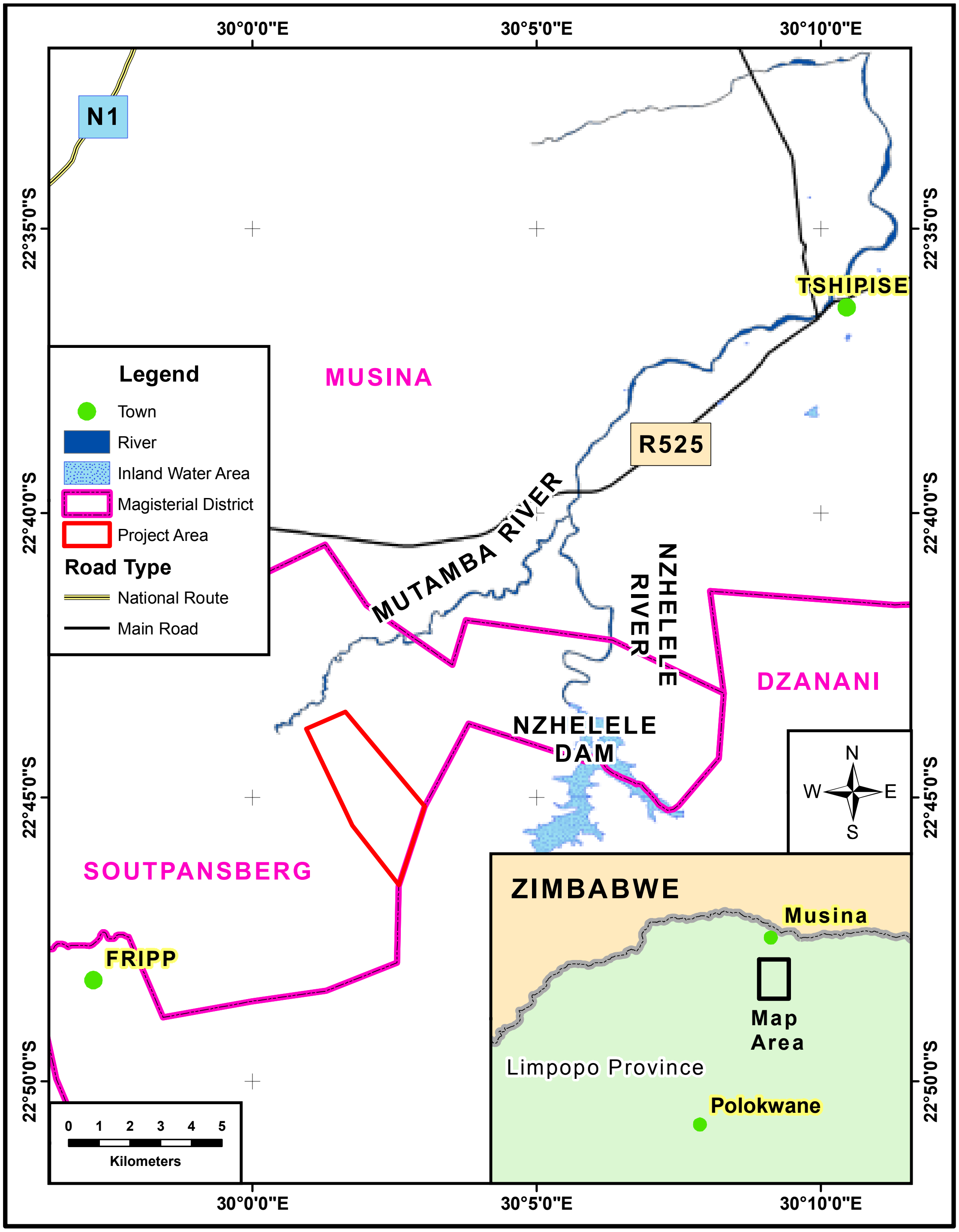

Figure 1: Location map showing the position of the Subiflex (Pty) Ltd's proposed coal mining Project are.

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 INDEPENDENCE

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 Subliflex (Pty) Ltd or the proposed mine project.

6 GEOLOGY AND FOSSIL POTENTIAL

The mining project is located in the Tshipise Coalfield of the Tshipise Basin. The location and shape of the Tshipise Basin was controlled by ENE-WSW trending faults that follow the trend of the Limpopo Mobile belt located immediately to the north (Johnson *et al*., 2006). Coal exploration drilling program conducted by Subiflex (Pty) Ltd (as the prospecting Right Holder) as well as examination of geological maps of the area has identified that that the project area is underlain by strata of the Sibasa, Wyllies Poort and Nzhelele Formations (Palaeoproterozoic Soutpansberg Group); the Tshidizi, Madzaringwe, Mikambeni, Fripp, Solitude, Clarens Formations (Palaeozoic Karoo Supergroup). Strata assigned to the Soutpansberg Group underlie the central and northern portions of the Mining Right Application area (Figure 2). In Figure 2 the Tshidizi, Madzaringwe, Mikambeni and Fripp Formations are combined into the area indicated as "Undifferentiated Karoo Supergroup". A summary of the characteristics of the various strata underlying the project area and their fossiliferous potential follows.

6.1 Soutpansberg Group

The Palaeoproterozoic age rocks of the Soutpansberg Group rest unconformably on the Achaean granite-gneisses as well as upon the Blouberg Formation and possibly the Mogalakwena Formation of the Waterberg Group (Barker *et al*., 2006). The rocks of the Group comprise a volcanic and sedimentary succession that is subdivided into six formations (see Table 2).

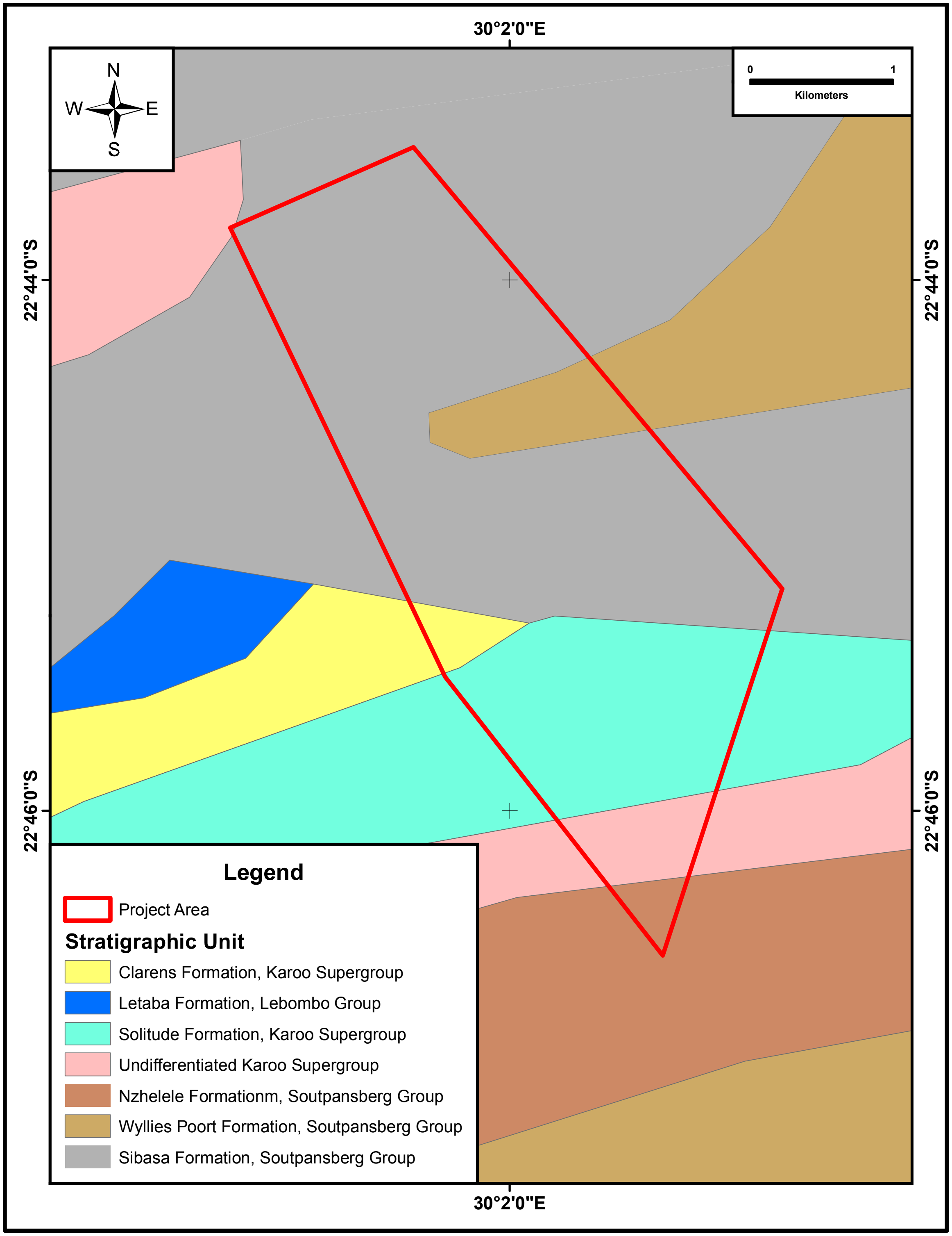

Figure 2: Geology of the area underlying Subiflex (Pty) Ltd's proposed coal mining project and the surrounding environs.

FORMATION	MEMBER
Nzhelele	Lukin Quartzite Mutale Tuff
Musekwa	
Wyllie's Poort	
Fundudzi	
Sibasa	
Tshifhefhe	

Table 2: Stratigraphic subdivision of the Soutpansberg Group (after SACS, 1980; Brandle, 1999).

The Soutpansberg sediments are believed to be have been deposited in a continental setting under fluvial conditions (Barker, 1979, 1983). The Soutpansberg Group units known to occur within the project area are the Sibasa, Wyllie's Poort and Nzhelele Formations.

6.1.1 Sibasa Formation

The Sibasa Formation is a dominantly volcanic succession, but contains several lenticular, laterally persistent intercalations of clastic sediments (Barker *et al*., 2006). The volcanic rocks represent a repetitive sequence of basalts, which also contain lenticular zones of pyroclastic rocks. The clastic rock intercalations consist of quartzite, shale and minor conglomerate and may locally be up to 400 m thick.

6.1.2 Wyllie's Poort Formation

The Wyllie's Poort Formation is an approximately 1 500 m thick clastic sequence consisting predominantly of pink quartzite sandstones with minor pebbles lenses (Barker *et al*., 2006). There are occasional minor intercalations of basaltic lava and pyroclastic rocks are present in the eastern part of the unit (Barker *et al*., 2006). The Wyllies' Poort Formation has been proposed to have been deposited either in a braided, mid-alluvial plain (Tankard *et al*., 1982) or on a proximal fluvial flood-plain system (Barker, 1979).

6.1.3 Nzhelele Formation

The Nzhelele Formation predominantly consists of red, argillaceous sediments, but arenaceous sediments are present in the upper portions of the formation. The maximum preserved thickness of the unit is approximately 600 m (Barker *et al*., 2006).

The lower, argillaceous portions of the Nzhelele Formation display convolute bedding and raindrop imprints (Barker, 1979). Higher up the unit becomes more sandy and thinly laminated, while near the top of the unit upward-fining sequences and trough cross-bedding cross ripple-laminations are present (Barker, 1979). The unit probably reflects a changing sequence of depositional environments from a distal upwards to a mid-alluvial flood plain (Barker, 1979). Palaeocurrent directions indicate a source area in the north and northwest (Barker, 1979).

6.1.4 Soutpansberg Group Palaeontological Potential

No fossil materials are known to occur within any of the lithological units comprising the Soutpansberg Group and the unit is accordingly considered unfossiliferous. The unfossiliferous nature of the unit is due to their Palaeoproterozoic age and, as such, they predate the evolution of metazoan life. Older carbonate rock assemblages within South Africa contain prolific stromatoilite assemblages, but the Soutpansberg Group lacks carbonates lithologies.

6.2 Karoo Supergroup

6.2.1 Tshidzi Formation

6.2.1.1 Geology

The Tshidzi Formation predominantly consists of diamictite containing clasts up to 2 m in diameter set in an argillaceous matrix; the unit attains a maximum thickness of 20 m. The sediments composing the unit were deposited in a glacial and fluvioglacial (braided stream) environments (Johnson *et al*., 2006).

6.2.1.2 Palaeontological Potential

The sediments of the Tshidzi Formation and its stratigraphic equivalents elsewhere in southern Africa are not known to be richly fossiliferous, but are known to contain 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 macro fossil assemblages to be expected within the Early Permian strata of South Africa have been summarised by Bamford (2004).

6.2.2 Madzaringwe Formation

The Early Permian Madzaringwe Formation consists of fluvial coarse-grained, micaceous sandstone with conglomerate "stringers" up to 6 m thick at the base. A distinct coal zone (containing up to 6 seams) up to 20 m thick forms the middle section of the formation. A coarse, red haematite stained, micaceous sandstone (up to 10 m thick) overlies the shales and forms the top of the Madzaringwe Formation. The shales and coals of the Madzaringwe Formation were probably deposited in floodplain and lacustrine conditions associated with the margins of meandering rivers. The sandstone unit that caps the formation probably represents point-bar and channel lag deposits (Johnson *et al*., 2006).

6.2.2.1 Palaeontological potential

The Madzaringwe Formation should be expected to contain plant macrofossils of the *Glossopteris* flora. Indeed, the author has identified fragments of *Glossopteris* material located within Madzaringwe Formation strata in a coal mine located west of Musina. During the coal exploration phase within the project area several fossilised leaf imprints were observed within the unit in the southern-most portion of the project area near the lower contact with the Tshidzi Formation (Figure 3). The author has not had the opportunity to identify these fossils as they have only been observed in photographs, but they appear to belong to the genus *Glossopteris.* The plant macro fossil assemblages to be expected within the Early Permian strata of South Africa have been summarised by Bamford (2004).

6.2.3 Mikambeni Formation

The Early Permian Mikambeni Formation comprises approximately 15 m of grey (occasionally carbonaceous) or yellowish shales and siltstones with occasional coal seamlets. These mudrocks closely resemble those of the Madzaringwe Formation, which occur below the thick, upper sandstone unit that caps the Madzaringwe Formation and, accordingly, represent a return to shallow lacustrine conditions (Johnson *et al*., 2006).

6.2.3.1 Palaeontological Potential

The Mikambeni Formation should be expected to contain plant macrofossils of the *Glossopteris* flora as are the other coal-bearing Early Permian strata of Southern Africa. The plant macro fossil assemblages to be expected within the Early Permian strata of South Africa have been summarised by Bamford (2004).

Figure 3: Leaf fossils found near the base of the Madzaringwe Formation within the project area. The fossils appear to be similar to the leaf form genus *Glossopteris* [photograph courtesy of Subiflex (Pty) Ltd].

6.2.4 Fripp Formation

The Triassic Fripp Formation comprises 5-10 m of clean, well-sorted, medium- to coarse-grained, white arkosic sandstone together with 'gritty' layers medium- to coarse-grained, white, feldspathic sandstones and grits with thin conglomeratic layers. The sandstones were probably deposited in fluvial point-bar and channel-lag deposits. The high feldspar content of the sandstone suggests provenance consisting of rapidly uplifted granitic rocks. This unit is correlated with the Molteno Formation of the Main Karoo Basin (Johnson *et al*., 2006).

6.2.4.1 Palaeontological potential

The unit is known to be fossiliferous within the Tshipese Basin, as fragments of the seed-fern *Dicroidium* have been identified with thin coal horizons in part of the basin (Van der Berg, 1980). It would also be a reasonable expectation that compressed, carbonised or silicified fossil wood fragments may be present within the unit within the coarse-grained sandstone and conglomerate facies that predominate in the succession.

6.2.5 Solitude Formation

The Solitude Formation generally consists of siltstones and very-fine sandstones with subordinate grey mudstones, but tends to become dominated by red colours towards the top of the unit. The multicoloured nature of the sediments as well as the presence of climbing ripples is typical of fine-grained distal floodplain overbank and crevasse-splay deposits associated with meandering streams. (Johnson *et al*., 2006).

6.2.5.1 Palaeontological Potential

The dinosaur *Euskelosaurus*, has been found in Nyalaland in the north of the Kruger National Park and on the Tshikondeni Mine grounds to the west of Nyalaland (Durand, 1996; 2001) in rocks of the Solitude Formation. Accordingly, other vertebrate fossils of the *Euskelosaurus* Zone (including dinosaurs, advanced mammal-like reptiles and other reptiles) may be present within the formation where it occurs elsewhere. Based on the presence of *Euskelosaurus* within the formation elsewhere it is evident that the Solitude Formation correlates with the lower Elliot Formation of the Main Karoo Basin.

6.2.6 Clarens Formation

The Clarens Formation is composed almost completely of predominantly cream coloured, massive, well-sorted, fine-grained sandstones consisting of well-rounded quartz grains. Most of the sandstone is considered to be aeolian in origin, but there is a minor component of the formation (particularly near the base of the unit) that consists of coarse-grained, detrital material deposited by ephemeral streams (Johnson *et al*., 2006).

6.2.6.1 Palaeontological Potential

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

7 ENVIRONMENT OF THE PROPOSED PROJECT SITES

The area for the proposed coal mine is relatively large, being approximately 889 ha. Examination of Google earth imagery (Figure 4) indicates that the southern-most portion of the project area upon the northern-most slopes of the Soutpansberg Mountain Range and extends northwards towards the Mutamba River. The Nzhelele Dam lies close to, and west of, the project area. Figure 5 shows that the project area also contains a region of hilly topography within its central to northern portions. Figure 5 also indicates that Makhushu Village lies immediately adjacent to the south-eastern margin of the project area.

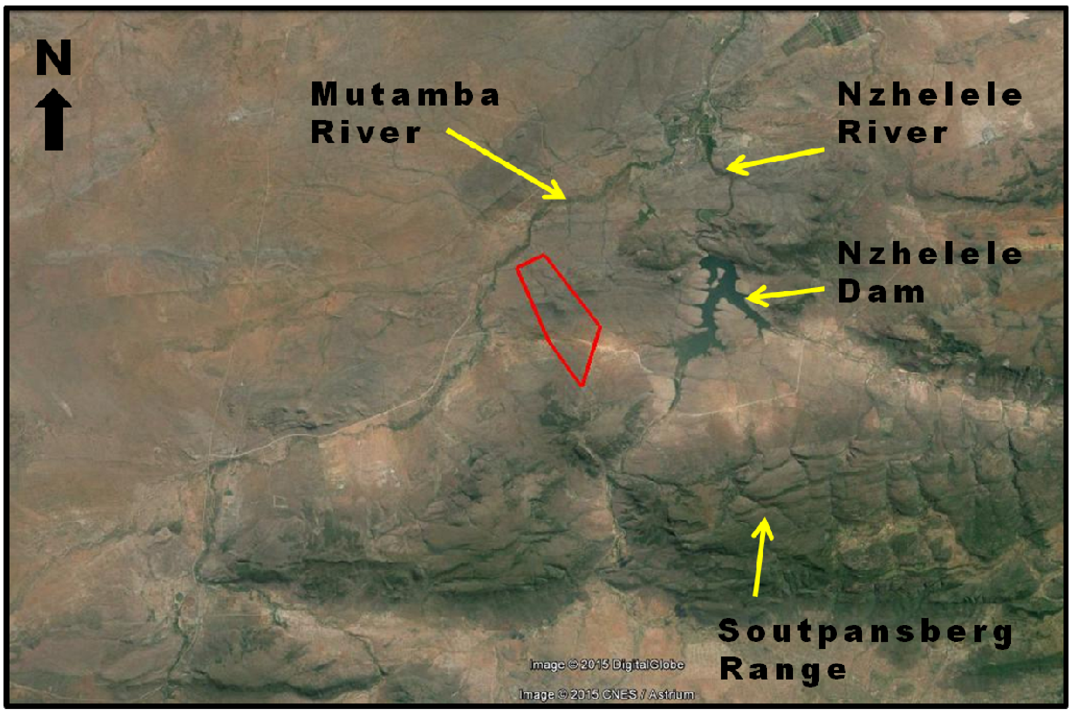

Figure 4: Google earth image of the area underlying the proposed mining operations (red polygon) and the surrounding environs.

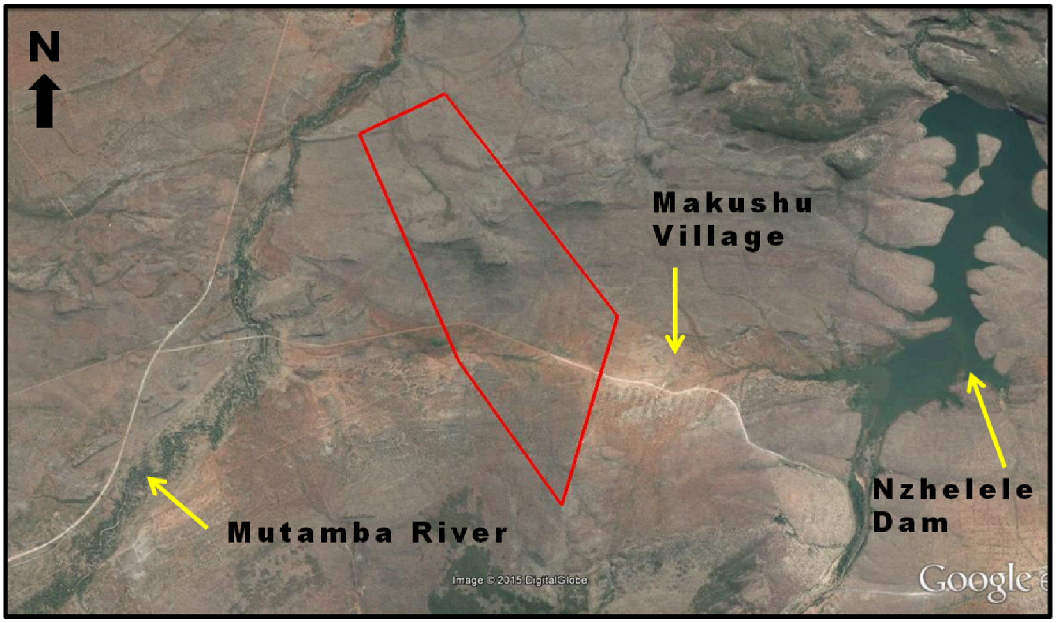

Figure 5: Google earth image of the project area (red polygon) and is surrounding environs at a higher magnification than in Figure 4. Makushu Village lies immediately adjacent to the south-eastern corner of the area. The landscape does not appear to be as heavily forested compared to the hills evident in the northeast corner of the image.

The natural vegetation cover of the project area consists of the Limpopo Ridge Bushveld and Musina Mopane Bushveld veld types (Figure 6). The former occurs within the Soutpansberg Mountain Range in the south and the hilly ground (underlain by rocks of the Soutpansberg Group) in the northern portions of the area. The Musina Mopane Bushveld occurs in all other regions of the project area and appears to be restricted to regions of flatter topography. The conservation status of the Limpopo Ridge Bushveld is described by Mucina and Rutherford (2006) as vulnerable, while that of the Musina Mopane Bushveld is categorised as least threatened.

It is evident from Figure 7 that the project area is topographically hilly in the southern-most and northern portions of the project area. The topographically flatter regions of the area feature a prominent series of dendritic, ephemeral fluvial drainage line. These drainage lines drain to the west and north-west where they eventually join with the Mutamba River.

8 OVERVIEW OF SCOPE OF THE PROJECTS

The envisaged mine will operate via a mix of open cast and underground mining operations. The expected life of mine is 25 years. The mining method for the open pit area is a conventional drill and blast operation with truck and shovel, load and haul.

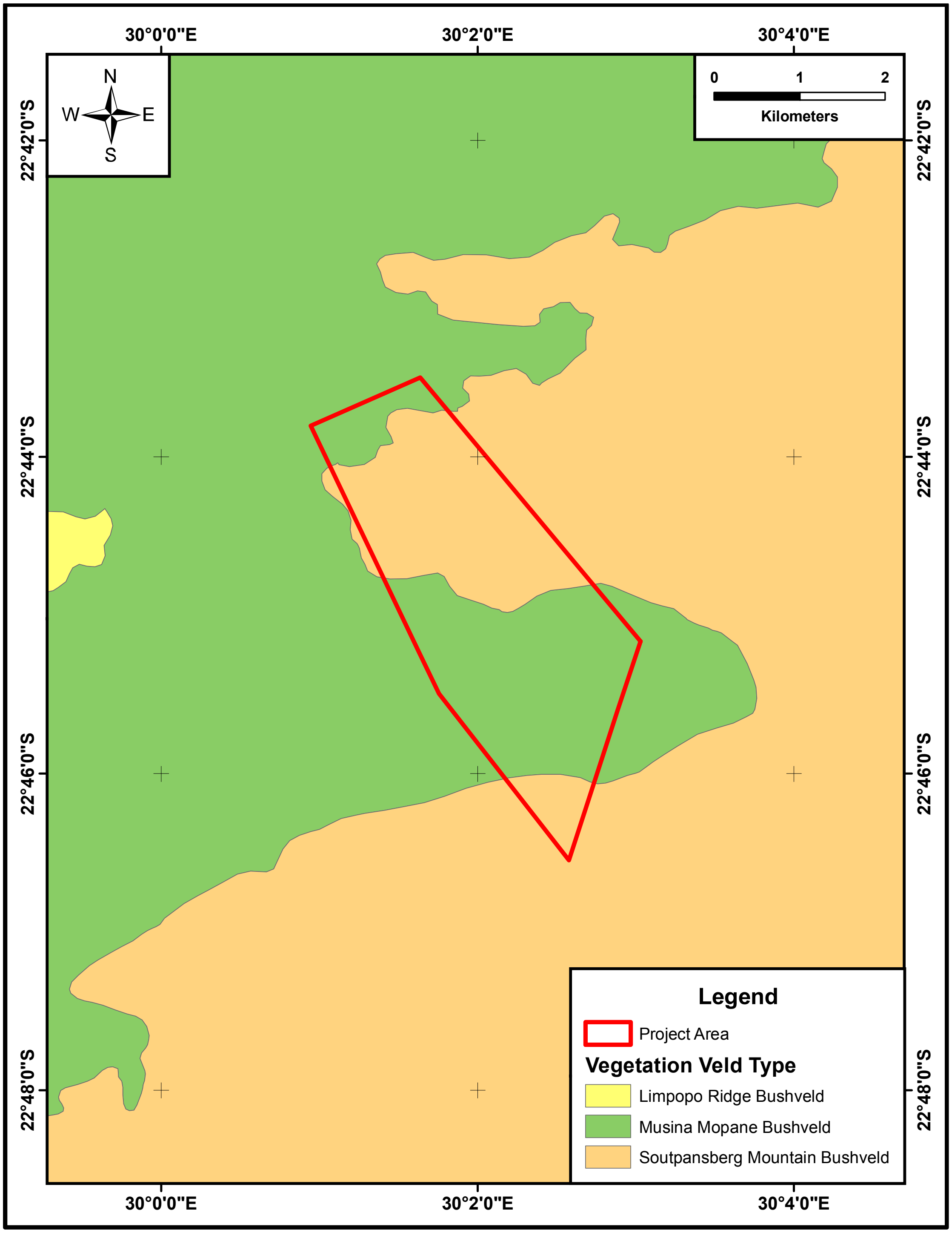

Figure 6: Map of the distribution of the vegetation veld types located beneath the project area and its immediate environs (after Mucina and Rutherford, 2006).

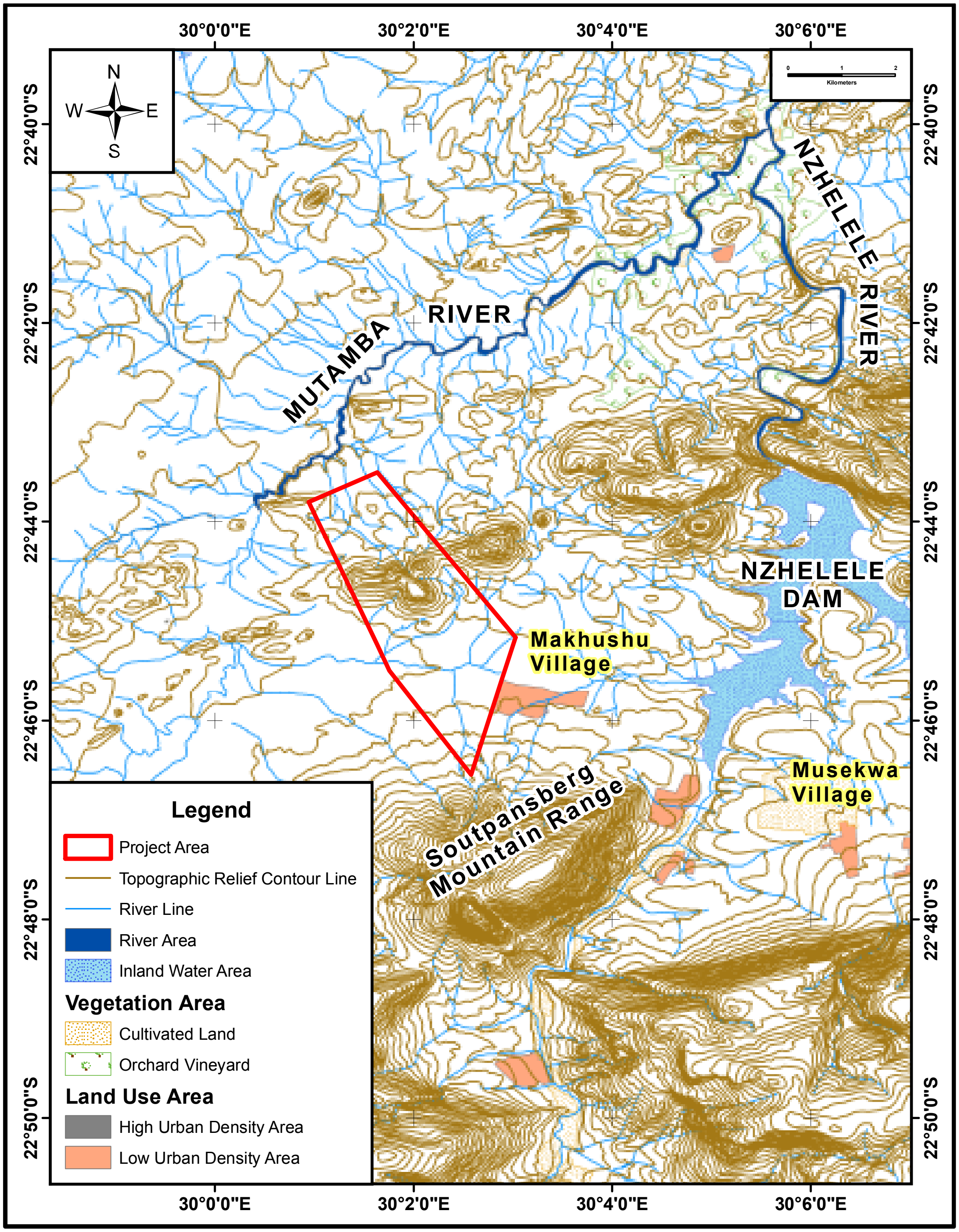

Figure 7: Topographic map of the project area. The proposed mine lies between the Soutpansberg Mountain Range to the south, the Nzhelele Dam to the east and the Mutamba River to the north. A dendritic, ephemeral drainage system is present within the project area and drains to the north and west into the Mutamba River. The topographic relief contour interval of the map is 20 m.

Underground mining operations will commence from year 10 onwards for a period of 5 years. Access will be from selected positions in the open pit and the coal will be mined through the long-wall methodology. After underground activities have been completed, the access to the underground areas will be closed followed by the final rehabilitation of the open pit.

The proposed infrastructure to be developed includes:

- Coal Handling Processing Plan
- Overburden Waste Dump;
- Temporary Discard Dump;
- Haul roads;
- Pollution Control Dams;
- Raw water storage facility and distribution systems;
- Access road; and
- Auxiliary infrastructure including a workshop and store, office and change house, electrical power supply and security fencing.

The washed coal will be transported via road to a nearby siding. The final discard material from the plant will be disposed of in the mined-out open pit. In the event that the pit is unavailable due to existing mining activities, the discard material will be placed on an interim surface discard dump, from where it will be reclaimed and dumped into the mined-out open pit towards the end of the mine life as part of the rehabilitation of the mining site. The location of the various infrastructure elements that will comprise the mining operations is shown in Figure 8.

8.1 Effect of projects on the geology

It may be interpreted from Section 8 above that the development anticipated within the mining project will have a variety of effects on the underlying geological units. Many of the infrastructure items such as roads will only affect the land surface directly. The built structures may require deeper excavations for foundations and may be expected to result in the disruption of the upper-most 1-2 m of the land surface. Figure 8 indicates the planned aerial extent of the surface infrastructure elements associated with the mining operations. It is evident from Figure 9 that almost the entire aerial extent of the superficial exposures of the Solitude and Clarens Formations occurring within the project area will be affected. These units are known to contain important vertebrate fossil assemblages elsewhere in their extent. Similarly, significant proportions of the area indicated as "undifferentiated Karoo Supergroup" (i.e., the Fripp, Mikambeni and Madzaringwe Formations) that are known to contain significant plant macrofossil assemblages will be directly affected by the open cast mining activities. At the most extreme end of the range of negative impacts the mining activities will result in the total disaggregation and removal of the mined material and will result in the permanent

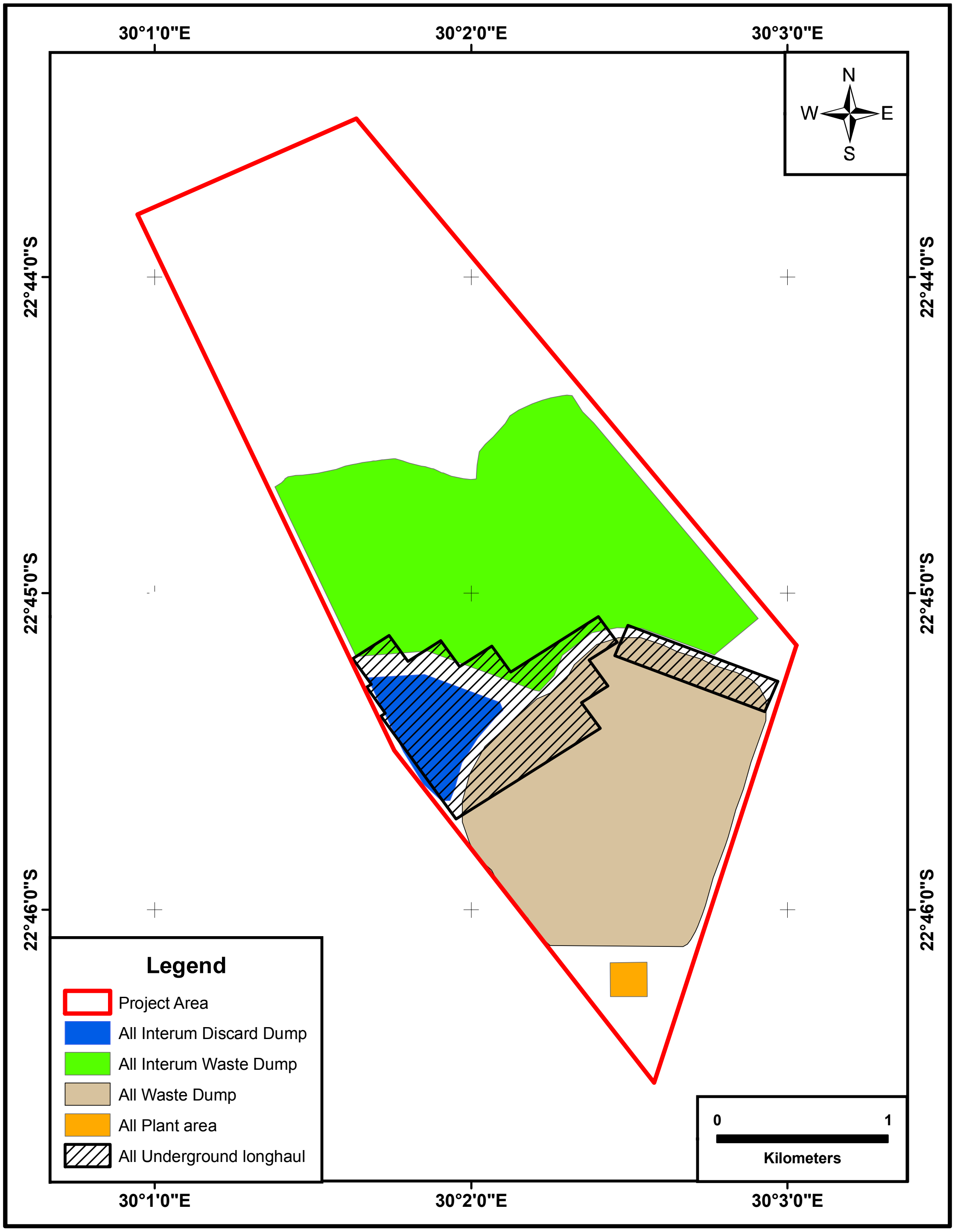

Figure 8: The location of the various infrastructure elements that will comprise the mining project. The area indicated as the "All waste dump" represents the location of the open cast pit void after it has been in filled with waste rock from the beneficiation plant.

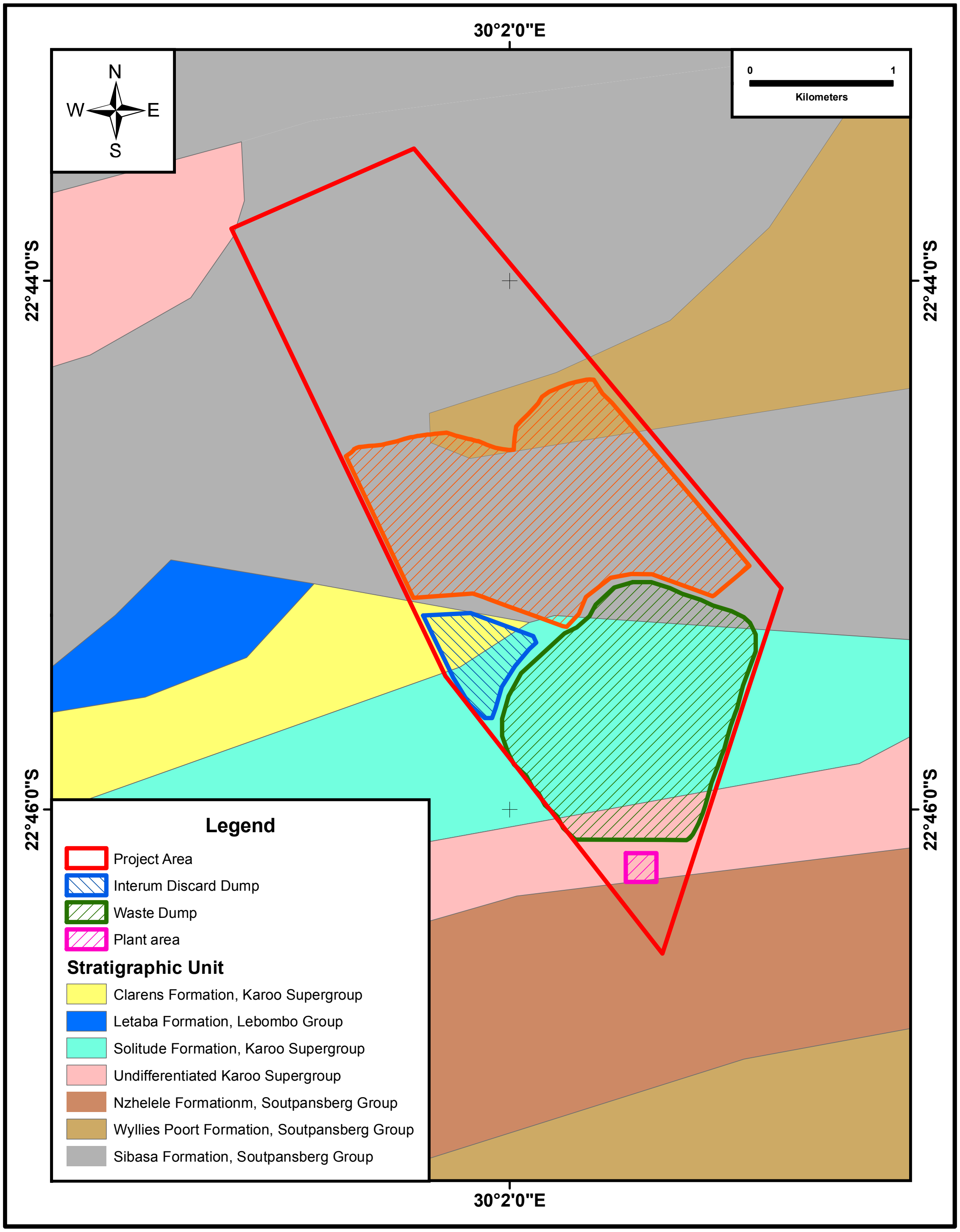

Figure 9: Geological map of the area underlying the proposed mining project area showing the planned aerial extent of the surface infrastructure required for the operation of the mine.

and total destruction of any fossil materials contained within the mined rock.

The mining activities will be undertaken using two mining methods, these being open cast mining and underground mining. The open cast method will result in the disaggregation and removal of all strata from the land surface down to the base of the pit. Effectively, the base of the pit will be located at the base of the lowest coal seam mined. During this phase of the mining activities, the Madzaringwe Formation will be the target of the mining, but the overlying Mikambeni and Fripp Formations will need to be stripped to expose the coal-bearing Madzarinwe Formation.

Access to the underground mining activities will be via the existing open cast pit (thus, no new shaft will be required for access). The underground mining process will selectively mine the coal seams themselves, as well as any intervening or intercalated sandstone or argillaceous strata. Accordingly, the negative impacts on the geological strata will be restricted to this rock facies and the overlying strata will remain unaffected (in contrast to the effects of the open cast mining). It is not expected that plant fossil material will be encountered within the coal seams themselves (due to the coalification process), but will be potentially present within the shale and sandstone partings within the coal seams. As mining progresses these sedimentary partings and the plant macrofossils they contain may be exposed in the mine working face. These exposures could be inspected to ascertain their fossil content in-between episodes of active mining.

9 IMPACT ASSESSMENT

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

9.1 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.

9.2 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).

9.3 Duration of impact

The anticipated duration of the identified potential impact is assessed as potentially **permanent to long term**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected) the damage or destruction of any palaeontological materials will be permanent. Similarly, any fossil materials that exist below the structures and infrastructural elements that will constitute the coal mine will be unavailable for scientific study for the life of the existence of those features. The life of the facility mine is expected to be 25 years, but the effects on the geology will be permanent.

9.4 Probability of impact

The sediments of the Ecca Group (represented by the Madzaringwe and Mikambeni Formations in this area) are known to be fossiliferous and are known for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora. Indeed fossils of this flora were identified within the Madzaringwe Formation of this region during the coal exploration phase of the project. 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 Ecca Group strata is **moderate**. It must be noted however, that where plant macrofossils are present within a sequence (as they have been proven to be in the Madzaringwe Formation) they are often in dense accumulations and the probability of a negative impact is accordingly assessed as being **moderate to probable**. The rocks of the Tshidzi Formation have a **low** fossiliferous potential, and underlie the coal-bearing strata in most areas, and as such, are unlikely to be affected by most of the mining activities.

The Fripp Formation usually consists of coarse-grained arenites and rudites and is generally unfossiliferous. However, plant macrofossils belonging to the *Dicroidium* Flora have been identified within the formation in the region. In general, the potential for any negative impact to the palaeontological heritage contained within this unit is characterised as **low**.

The Solitude and Clarens Formations are known to be fossiliferous and have historically yielded a diverse fauna of dinosaurs, synapsid reptiles and mammals. These fossils tend not to be common, but over such a large aerial extent as their outcrops within the project area, it is possible that fossil materials will be present. The probability of any negative impacts occurring upon the fossil heritage of these units is assessed as **low**. The rocks of these two formations will not be targeted for mining and, thus, will only be potentially be affected by the construction of superficial infrastructure elements.

All of the rock units constituting the Soutpansberg Group are unfossiliferous and, accordingly, the potential for any negative impact on the palaeontological heritage is **nil**. The rocks of this stratigraphic unit comprise the majority of the aerial extent of the project area and will not be targeted by the mining activities. Therefore, the greater the amount of mine infrastructure elements that are constructed on these bedrock areas the lower the potential for the project, as a whole to impact on the fossil record will become.

9.5 Significance of the impact

Should the proposed projects progress without due care to the possibility of fossils being present within the rocks of the Karoo Supergroup the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. This 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 Tshidzi, Madzaringwe and Mikambeni Formations 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 Fripp Formation is also known to contain scientifically important plant macrofossils belonging to the *Dicroidium* flora. These fossils provide a rare window (in southern Africa) into the Triassic plant communities of the region. Thus, as with the *Glossopteris* flora of the older Permian strata of the area, 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 Solitude and Clarens Formations are both known to contain scientifically highly significant vertebrate fossil faunas elsewhere in their extent. These faunas document the early stages of the evolution of dinosaurs, later stages of the evolution of mammals form reptiles as well as some of the earliest mammal faunas in the geological record.

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.

9.6 Severity / benefit scale

The project will provide coal for the production of electricity and, thus, help alleviate pressure on an increasingly strained national power grid. Accordingly, the proposed projects are categorised, herein, as being potentially **beneficial.**

The probability of a negative impact on the palaeontological heritage of the project areas has been categorised as moderate in the worst case. However, the implementation of suitable damage mitigation and avoidance protocols, as outlined below, will significantly minimise the probability of any negative impact occurring. Indeed, the progress of the project may even result in making fossils available to the scientific community that may be otherwise unavailable for study.

9.7 Status

The proposed projects would assist in the provision of electricity to the national power grid, which is currently regularly failing to meet the demands placed upon it. As such, the projects are determined as having a **positive status** herein.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

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

10.1 Mitigation

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

- A thorough examination by a palaeontologist is required on the exposures of the Karoo Supergroup strata present within the project area (i.e., a Full Palaeontological Impact Assessment Study on these exposures) before the commencement of the project. This would allow a meaningful evaluation of the presence of potentially fossiliferous strata within that area. If fossil materials prove to be present the process would allow the identification of any such fossils that should either be protected completely or could have damage mitigation procedures emplaced to minimise negative impacts.
- Should any fossil materials be identified SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance as part of a Phase 2 Palaeontological Impact Investigation study.
- A significant potential benefit of the examination of the mine excavations associated with the construction of the projects is that currently unobservable fossils may be uncovered.
- Suitable staff members of the mining company (e.g., the environmental officer) who have the correct training and clearance to access the working mine faces should be trained to recognise the types of fossils that may be encountered during the ongoing mining operations. It is unlikely that plant macrofossils will be encountered in the coal seam(s), but may well be encountered in the hanging and foot walls as well as in any siliciclastic partings contained within the coal (and that will be exposed on the working mine face).
- The mining company should mandate the trained employees to make regular examinations of the working mine faces and determined if fossil materials are present. The interval between inspections will be dependent upon the rate of progress of the mining activities, but should not be conducted on less than a monthly basis.
- If fossil materials are identified, the infrastructure construction or the mining activity in that area should be temporarily halted and a professional palaeontologist contracted to assess the scientific value of the fossils.

- Should scientifically or culturally significant fossil material exist within the project areas the negative impact upon it would be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution.

10.2 Reversal of damage

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

10.3 Degree of irreversible loss

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

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

11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a desktop study of available maps and scientific literature; no direct observation was made of the area as result of a site visit.

Fossils are sporadic and unpredictable in their occurrence. The presence or absence of fossils in any area cannot be predicted with confidence.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop Palaeontological Impact Assessment Study has been conducted on the location of the proposed Subliflex (Pty) Ltd's coal mine. The project area is large with an aerial extent of 889 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 rocks of the Soutpansberg Group are unfossiliferous and any development associated with the project that occurs upon exposures will result in nil negative impact upon the palaeontological heritage.

The potential for a negative impact upon the palaeontological heritage of the coal-bearing strata of the Ecca Group (the Madzaringwe and Mikambeni Formations) is assessed as moderate; that of the underlying Tshidzi Formation is assessed as being low. However, all three formations should be expected to contain highly scientifically significant plant macrofossils of the *Glossopteris* flora. Any negative impact upon these fossil floras would result in a high negative impact. The probability of such a negative impact is elevated by the fact that both the Madzaringwe and Mikambeni Formations will be targeted during the open cast mining phase and the Madzaringwe Formation will be targeted during the underground mining phase.

The fossil potential of the Triassic Fripp Formation is assessed as being low, but it is known to contain plant macrofossils belonging to the highly scientifically significance *Dicroidium* flora. Accordingly, any negative impact caused by the mining operations would be of high significance. This unit will not be targeted during the mining operations and, as a result, any negative impacts caused by the construction will be limited to the upper-most 1-2 m of the land surface.

The Solitude and Clarens Formations are known to be fossiliferous and to contain diverse vertebrate fossil faunas. However, vertebrate fossils are usually sparsely distributed and relatively uncommon. As such, the probability of a negative impact upon these fossil faunas has been assessed as low. However, the vertebrate faunas are of the highest scientific significance and any negative impacts would be highly significant.

The potential negative impacts of the project must be balanced against the fact that the proposed mining project aims to provide coal for the production and supply of electricity to an increasingly strained national power grid. The project is assessed as being beneficial and having a positive status should the the negative impacts of the project being mitigated to the maximum practical extent. The following damage mitigation protocols are recommended:

- A thorough examination by a palaeontologist is required on the exposures of the Karoo Supergroup strata present within the project area (i.e., a Full Palaeontological Impact Assessment Study on these exposures) before the commencement of the project. This would allow a meaningful evaluation of the presence of potentially fossiliferous strata within that area. If fossil materials prove to be present the process would allow the identification of any such fossils that should either be protected completely or could have damage mitigation procedures emplaced to minimise negative impacts.

- Should any fossil materials be identified SAHRA informed of the discovery (as required in Section 3.3 above). A palaeontologist should then be mandated to inspect the fossil materials and ascertain their scientific and cultural importance as part of a Phase 2 Palaeontological Impact Investigation study.
- A significant potential benefit of the examination of the mine excavations associated with the construction of the projects is that currently unobservable fossils may be uncovered.
- Suitable staff members of the mining company (e.g., the environmental officer) who have the correct training and clearance to access the working mine faces should be trained to recognise the types of fossils that may be encountered during the ongoing mining operations. It is unlikely that plant macrofossils will be encountered in the coal seam(s), but may well be encountered in the hanging and foot walls as well as in any siliciclastic partings contained within the coal (and that will be exposed on the working mine face).
- The mining company should mandate the trained employees to make regular examinations of the working mine faces and determined if fossil materials are present. The interval between inspections will be dependent upon the rate of progress of the mining activities, but should not be conducted on less than a monthly basis.
- If fossil materials are identified, the infrastructure construction or the mining activity in that area should be temporarily halted and a professional palaeontologist contracted to assess the scientific value of the fossils.
- Should scientifically or culturally significant fossil material exist within the project areas the negative impact upon it would be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an appropriately permitted institution.

This desktop study has not identified any palaeontological reason to prejudice the progression of the proposed mining operations subject to the recommended damage mitigation procedures being enacted.

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