DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSEMENT REPORT ON THE SITE OF FOUR ALTERNATIVE ROAD LOCATIONS (ALTERNATIVES 1-4) FOR A PROPOSED RING ROAD AROUND ERMELO, MPUMALANGA PROVINCE

22 February 2014

Prepared for:

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Prepared for:

Interdesign Landscape Architects (Pty) Ltd

On Behalf of:

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Prepared By:

Dr B.D. Millsteed

EXECUTIVE SUMMARY

The South African National Roads Agency (SANRAL) is in the process of determining the preferred route for the proposed ring road around the town of Ermelo in Mpumalanga Province.

SANRAL have appointed Aecom South Africa (Pty) Ltd to determine alternative routes for further investigation as part of the EIA process. To date, three alternative routes have been identified as part of the scoping phase. The three identified alternative routes will be designed with the aim to establish a limited access freeway designed to National Road Standards, incorporating a road reserve of approximately 80 m, wide enough to accommodate four traffic lanes from either direction, various structures in the design include underpasses, river bridges, cuttings, embankments, culverts, interchanges etc. A fourth alternative (Alternative 4) proposed by Interested and Affected Parties (I&APs) involves the upgrade of the existing road network to accommodate through traffic in Ermelo. The four alternative project routes are located within the town of Ermelo and its immediate environs, Mpumalanga Province.

SANRAL have appointed Aecom South Africa (Pty) Ltd to determine alternative routes for further investigation as part of the EIA process. Interdesign Landscape Architects (Pty) Ltd have been appointed by Aecom South Africa (Pty) Ltd to manage the environmental application process for the proposed alternative routes. Interdesign Landscape Architects (Pty) Ltd has appointed BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project.

The project area is extensively underlain by Permian sedimentary rocks of the Vryheid Formation, but igneous rocks of the Karoo Dolerite Suite crop out over a large area located south of Ermelo. Portions of the road systems contemplated in Alternatives 1-3 pass across these dolerites.

Alternatives 1-4 are all primarily located upon rocks of the Vryheid Formation. The probability of a negative impact on the fossil heritage of the area can be quantified in the following manner. The probability of a negative impact on the palaeontological heritage of the Vryheid Formation is moderate due to the generally scarce and erratic distribution of fossils within the unit; but both plant macrofossils and trace fossils tend to occur in prolific numbers where they do occur. Any negative impact upon the fossil assemblages contained within this geological unit is characterised as potentially highly scientifically and culturally significant. The area of any potential negative impact caused by the project is characterised as local in extent as all negative impacts will be restricted to the locality of project infrastructure. Similarly, the zone of permanent disruption is vertically restricted to the maximum depth of any excavations associated with the road constructions (1-2 m). Alternative 4 is located within the built environment of Ermelo and will only involve alteration to existing road infrastructure. Accordingly, it is not

anticipated that any construction associated with Alternative 4 will result in new, negative impacts upon the fossil heritage of the area. The rocks of the Karoo Dolerite Suite are considered to be unfossiliferous; thus, the proposed project poses no probability of any negative impact upon the palaeontological heritage of this unit.

The project has been assessed as being socially beneficial, herein, as it would facilitate ease of passage for transient road traffic through the Ermelo area. Similarly, the town of Ermelo would benefit by having the disruption to the local traffic system caused by high volumes of large, long distance transport trucks minimised. A series of recommendations are outlined herein that, if implemented, would minimise the possibility of any negative impact on the palaeontological heritage of the project area. A potential positive outcome of these mitigation protocols could be that fossil materials become available for scientific study that would otherwise have been hidden within or beneath the regolith. Should such new palaeontological material be located as a result of this site investigation this could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

In summary, this desktop study has not identified any palaeontological reason to prejudice the progression of either Alternative Routes 1, 2, 3 or 4, subject to adequate mitigation programs being put in place.

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SANRAL have appointed Aecom South Africa (Pty) Ltd to determine alternative routes for further investigation as part of the EIA process. To date, three alternative routes have been identified as part of the scoping phase. The three identified alternative routes will be designed with the aim to establish a limited access freeway designed to National Road Standards, incorporating a road reserve of approximately 80 m, wide enough to accommodate four traffic lanes from either direction. Various structures in the design, include underpasses, river bridges, cuttings, embankments, culverts, interchanges etc. A fourth alternative (Alternative 4) proposed by Interested and Affected Parties (I&APs) involves the upgrade of the existing road network to accommodate through traffic in Ermelo. The four alternative project sites are located within the town of Ermelo and its immediate environs, Mpumalanga Province (Figure 1).

SANRAL have appointed Aecom South Africa (Pty) Ltd to determine alternative routes for further investigation as part of the EIA process. Interdesign Landscape Architects (Pty) Ltd have been appointed by Aecom South Africa (Pty) Ltd to manage the environmental application process for the proposed alternative routes. Interdesign Landscape Architects (Pty) Ltd has appointed BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

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

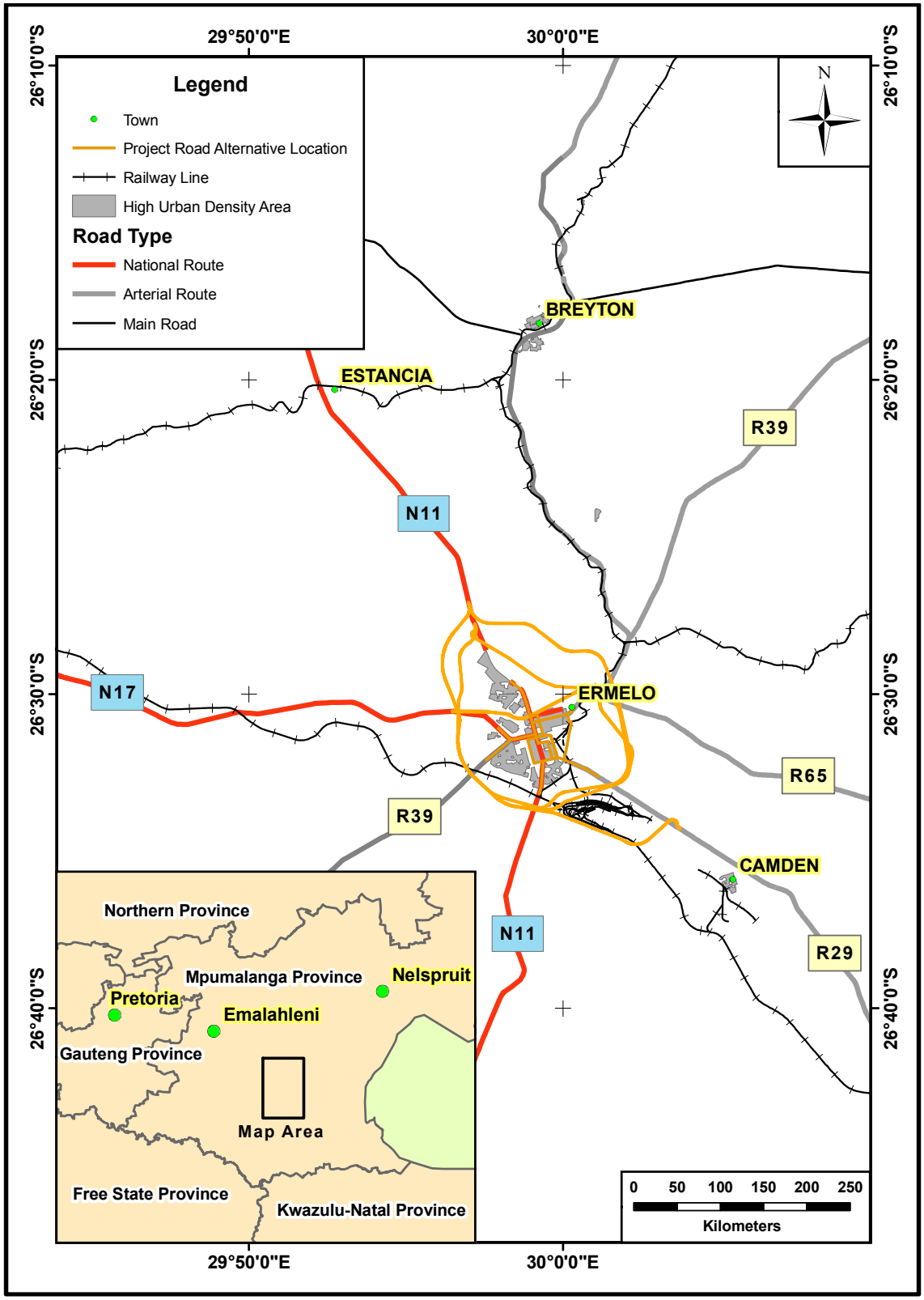

Figure 1: Location map showing the position of the proposed ring road alternative routes.

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.).

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

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

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

3.3 Legislation Specifically Pertinent to Palaeontology*

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

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

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite,
- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite,
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites,
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

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

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

3.4 The National Environmental Management Act [as amended]

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

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

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that

will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 RELEVENT EXPERIENCE

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

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this Palaeontological Heritage Impact assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either SANRAL or the proposed road building project.

6 OVERVIEW OF SCOPE OF THE PROJECT

Three alternative routes (named Alternatives 1-3 herein) have been identified as part of the scoping phase. The three identified alternative routes will be designed with the aim to establish a limited access freeway designed to National Road Standards, incorporating a road reserve of approximately 80 m, wide enough to accommodate four traffic lanes from either direction. Various structures in the design include underpasses, river bridges, cuttings, embankments, culverts, interchanges etc. A fourth alternative (Alternative 4) has been proposed by Interested and Affected Parties (I&APs) which involves the upgrading of the existing road network to accommodate through traffic in Ermelo. A description of the four alternatives follows.

6.1 Alternative 1

Alternative 1 (Figure 2) is a complete ring road around Ermelo measuring approximately 35 km in length. The ring provides a direct connection to the entire major road networks such being the N11, N17, N2, and the R39 & R65. The ring commences at the N11 just to the north of the Ermelo Golf Course, it continues in a southerly direction passing below the Douglas dam and through the Phumula residential township. From there it continues southward crossing the N17, the railway line and the R39 before intersecting the N11 at the proposed George Botha Park. From here, the alignment shifts northwards and passes east of the Nederland Park residential extensions 32 and 34 before

intersecting the N2. This route however requires an expensive skew bridge crossing over the Transnet Rail and Road system.

6.2 Alternative 2

Alternative 2 (Figure 3) measures 31 km and provides a western alignment similar to the part of the route forming Alternative 1. However, this western alignment is longer and does not pass through the Phumula and Nederland Park X32 and X34 residential townships. The western bypass commences at the N11 north of the Ermelo Golf course. It then continues in a southerly direction toward the N17, but following an alignment which passes the Douglas dam to the north. It intersects the N17 continuing southward intersecting the railway line and R39. After it passes through the proposed George Botha Park, it intersects the N11, and then continues in an easterly direction close to the existing railway alignment to link up with the N2.

6.3 Alternative 3

Alternative 3 (Figure 4) is a complete ring combination of Alternatives 1 and 2 as explained above, but excludes the north-eastern link which is underlain by mining activities. The total length of the route is approximately 34 km. Alternative 3 is the option preferred by SANRAL.

6.4 Alternative 4

Alternative 4 (Figure 5) was proposed by Interested and Affected Parties (I&APs) and involves the upgrade of the existing road network to accommodate through traffic in Ermelo. Three variations of this alternative are being considered, which include: maintaining the existing routes with only minor improvements at key intersections to enhance traffic flow; redefining the N11 to run along Border Street so that through traffic is directed around the CBD; or developing one-way street pairs in the north/south direction as an alternative to the current routing of the N11, using a combination of Church Street, Kleynhans Street and Border Street. No major road upgrading or new road links are considered as part of Alternative 4.

7 GEOLOGY AND FOSSIL POTENTIAL

Figures 6-9 show that the project area is extensively underlain by Permian sedimentary rocks of the Vryheid Formation. There is also an exposure of Jurassic dolerites of the Karoo Dolerite Suite that underlie portions of Alternatives 1, 3 and 4. A summary of the characteristics of the geological units and their fossiliferous potentials follows.

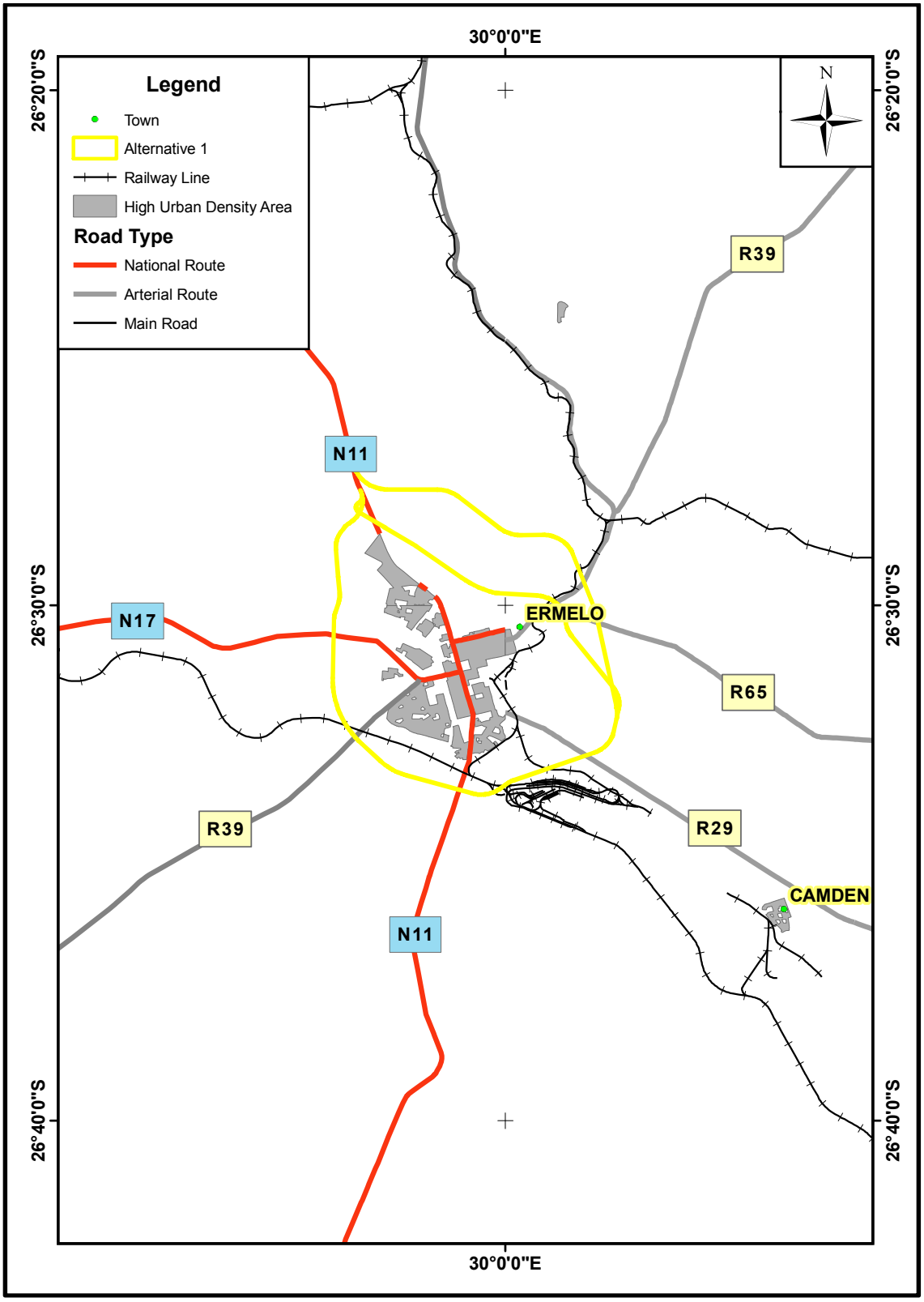

Figure 2: The proposed route for ring road Alternative 1.

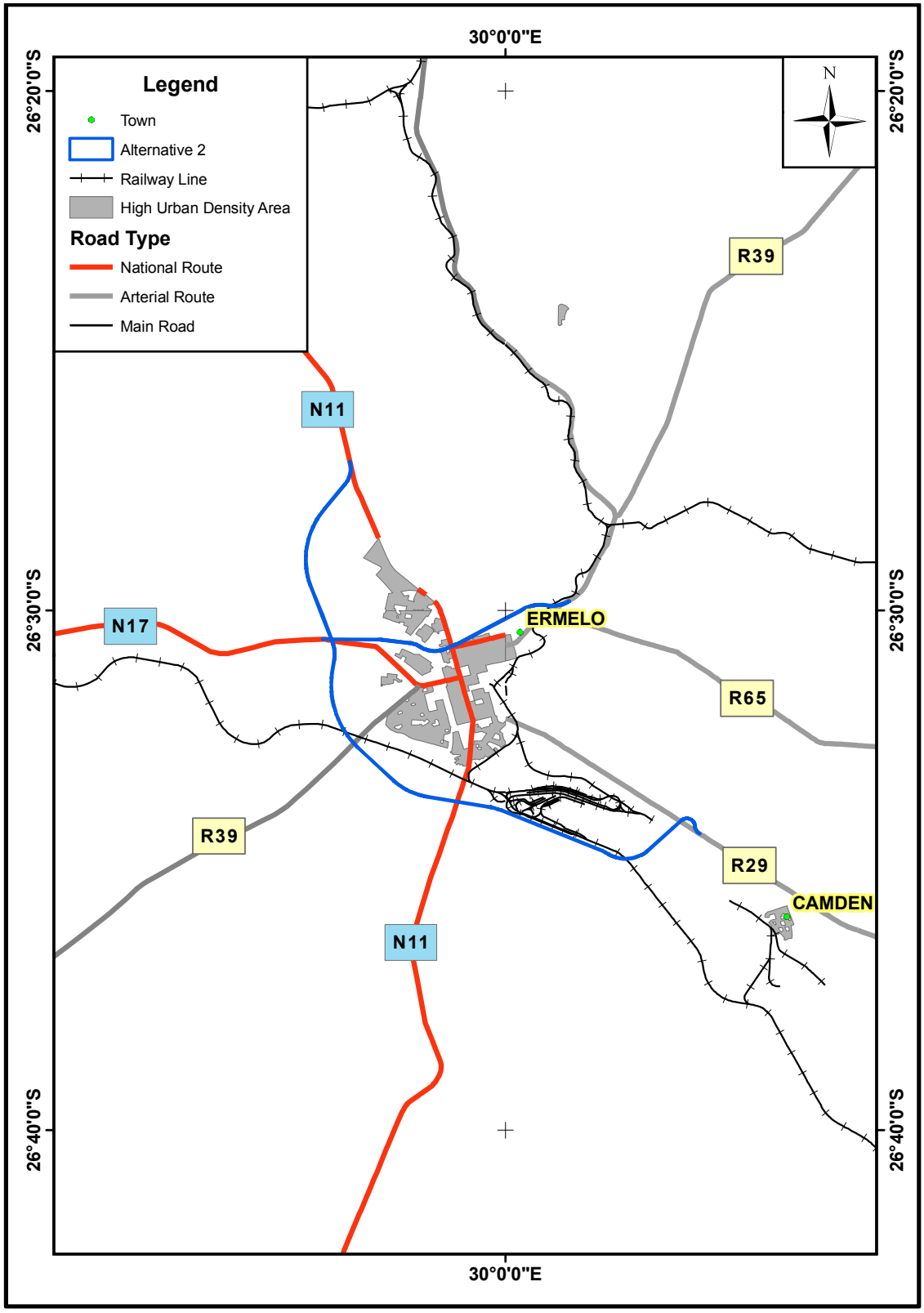

Figure 3: The proposed route of ring road Alternative 2.

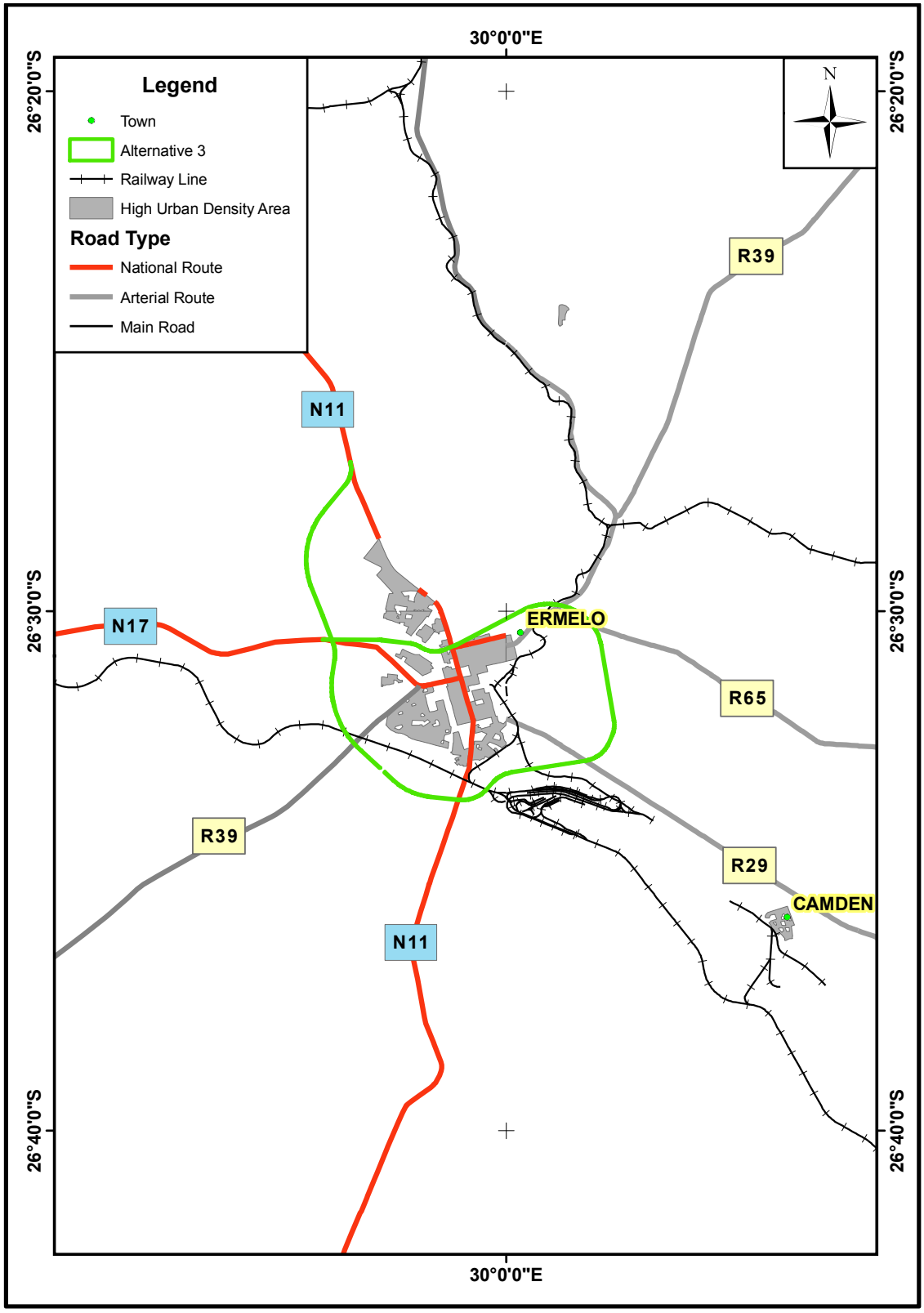

Figure 4: The proposed route of ring road Alternative 3.

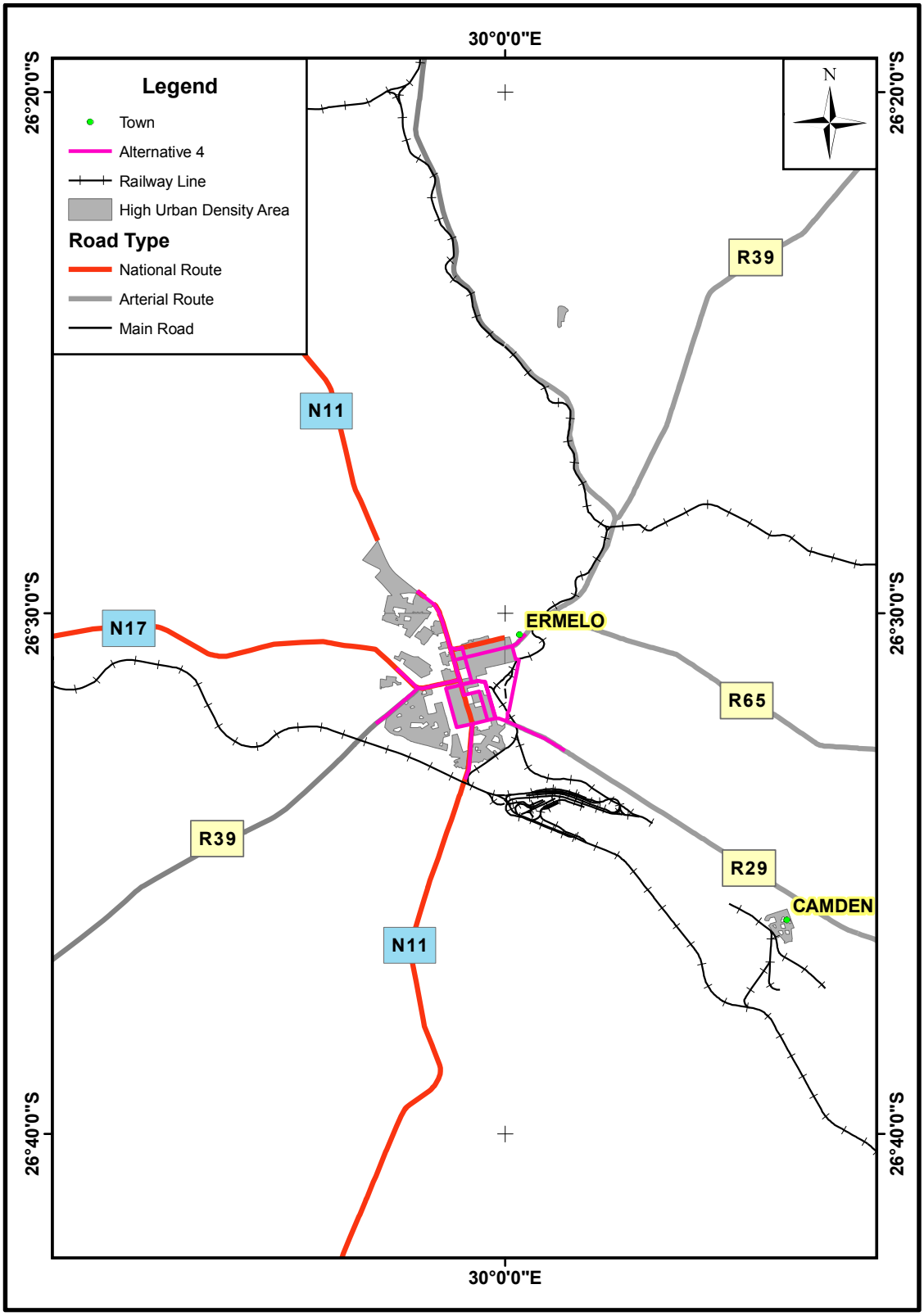

Figure 5: The proposed route of or ring road Alternative 4.

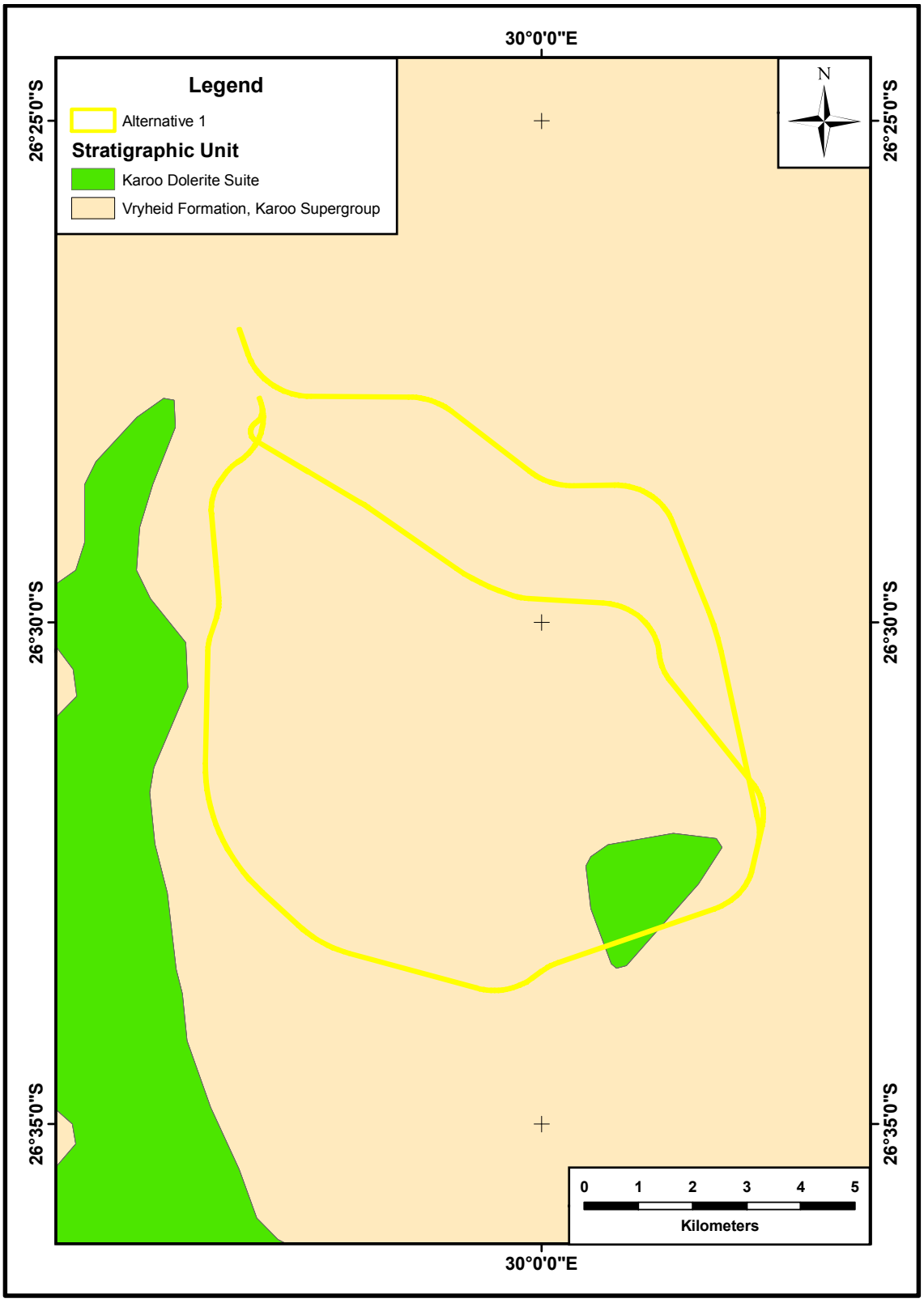

Figure 6: Map of the geology underlying Alternative 1 and its surrounding environs.

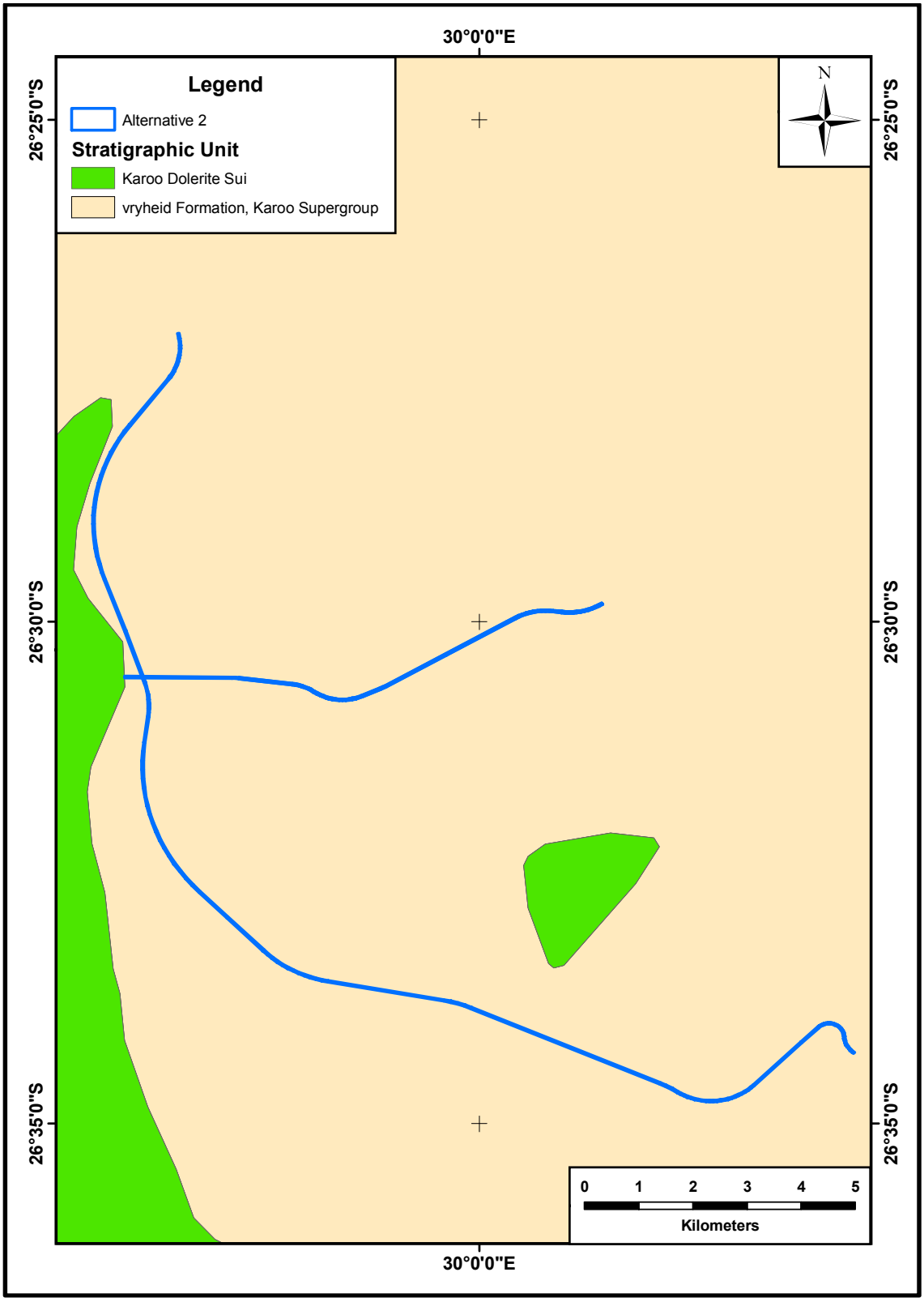

Figure 7: Map of the geology underlying Alternative 2 and its surrounding environs.

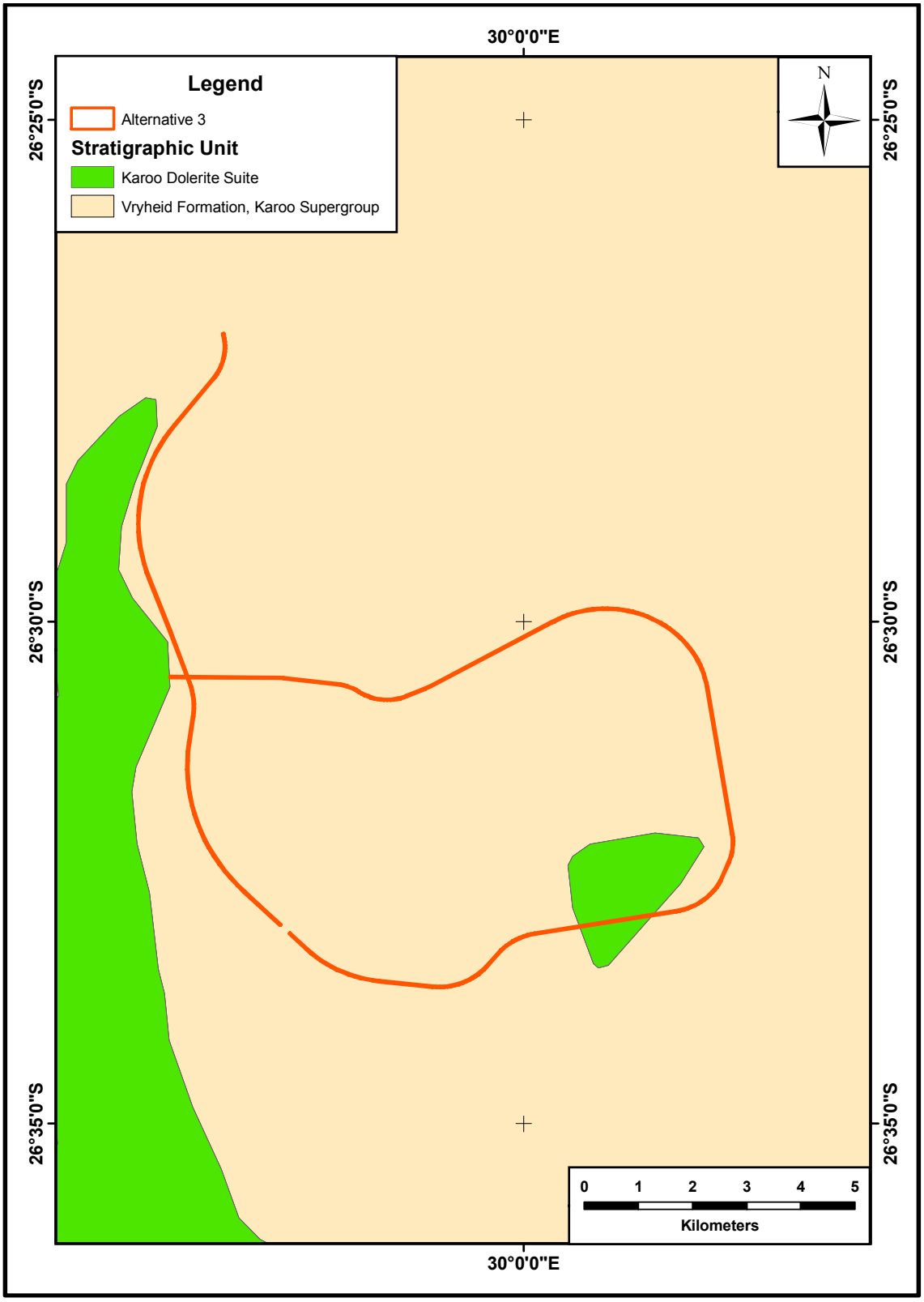

Figure 8: Map of the geology underlying Alternative 3 and its surrounding environs.

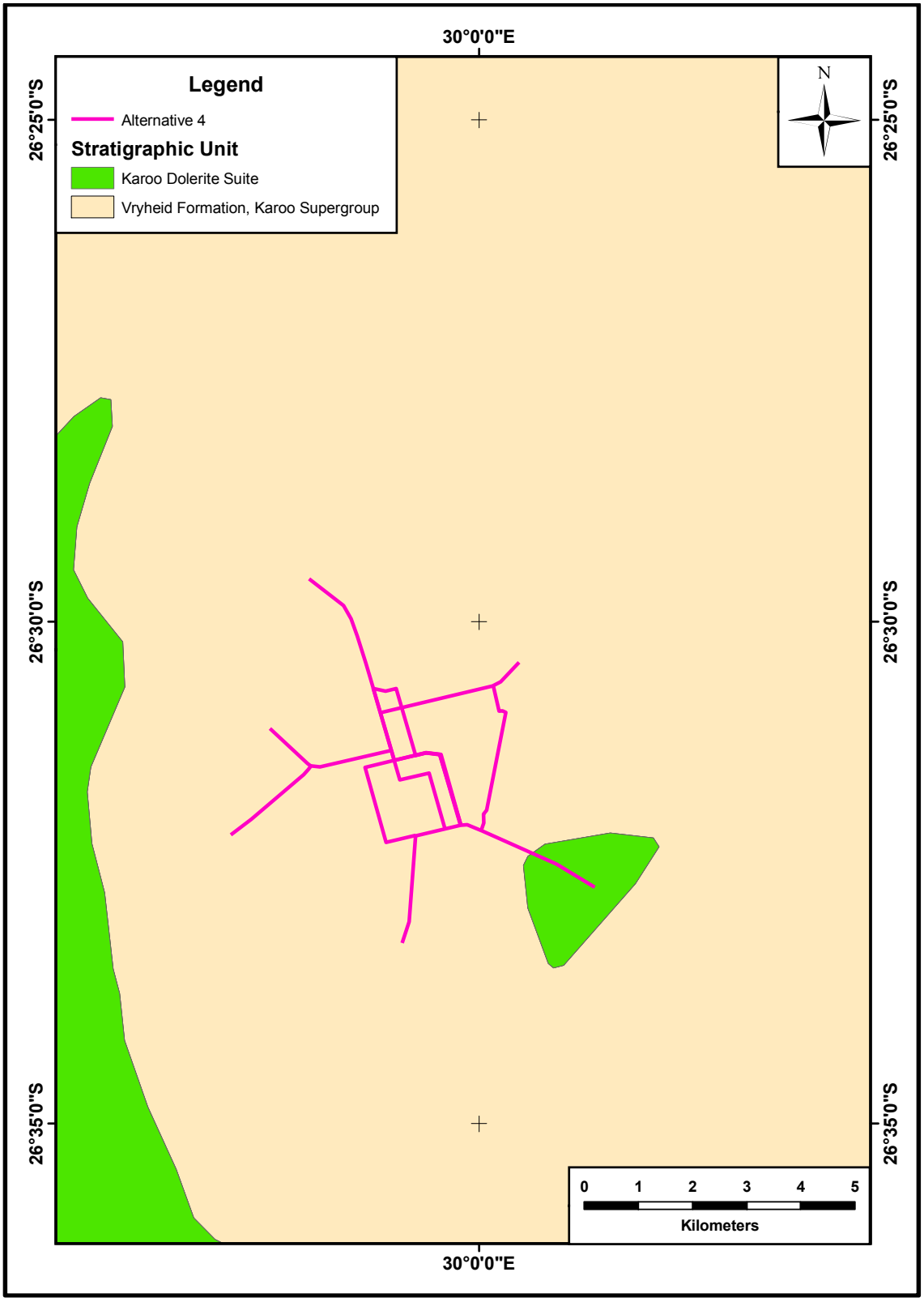

Figure 9: Map of the geology underlying Alternative 4 and its surrounding environs.

7.1 Vryheid Formation

7.1.1 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 Volkrust and underlying Pietermarizburg Formations; both of which are both are predominantly argillaceous (Figure 10). 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 10).

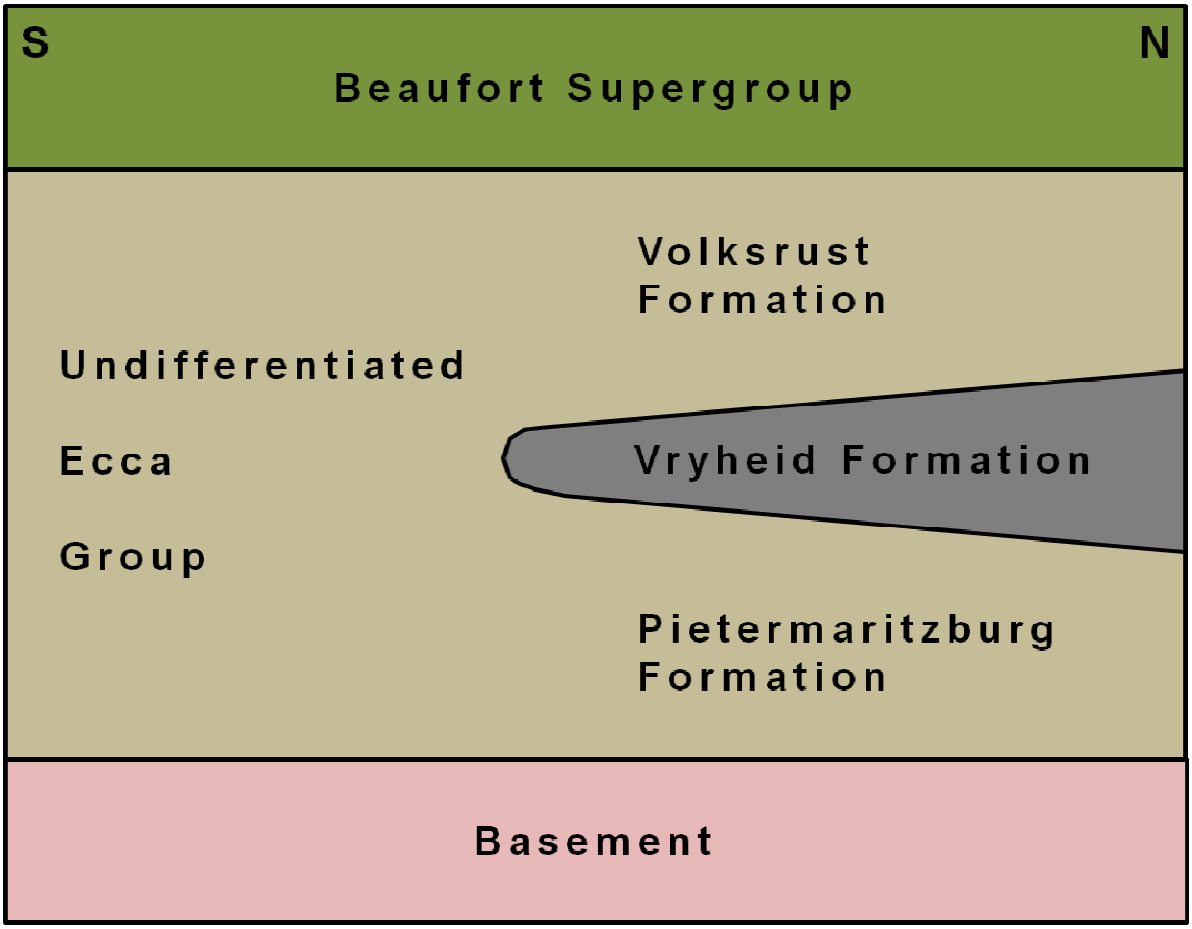

Figure 10: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

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

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

7.1.2 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 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.

7.2 Karoo Dolerite Suite

7.2.1 Geology

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

7.2.2 Palaeontological potential

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

8 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The aerial extent of the potential project infrastructure large, measuring a maximum extent of approximately 18 km from northwest to south east and approximately 10 km southwest to northeast. However, the majority of this area will be unaffected by the proposed constructions. This said, the length of each of the road systems required for each of Alternative Routes 1-3 is large (Alternative 1 = 35 km, Alternative 2 = 31 km and Alternative 3 = 34 km) and the width of the developments will be approximately 80 m (including verges), and as such cumulative area that will be affected in each alternative remains large. The road system associated with Alternative 4 is already extant, and is restricted to the present built environment of Ermelo. Thus, no new areas will be substantially impacted by the implementation of Alternative 4.

Topographically the area predominantly consists of a mildly undulating land surface which is extensively dissected by an ephemeral drainage network (Figures 11-18). No perennial drainage systems appear to be potentially directly affected by the proposed routes; however, there are several large dams present near the northern extents of Alternatives 1-3 (Figures 11-13).

Mucina and Rutherford (2006) indicate that the original vegetation cover of all four alternative road routes consists of the Eastern Highveld Grassland, Soweto Highveld Grassland and Amersfoort Highveld Clay Grassland veld types. Alternatives 1-3 are predominantly covered by Eastern Highveld Grassland, with subordinate areas of Soweto Highveld Grassland in their western-most extents and Amersfoort Highveld Clay Grassland occurring only in their southern-most extents (Figures 19-21). Alternative 4 was originally completely vegetated by the Eastern Highveld Grassland veld type (Figure 22). However, as Alternative 4 utilises only existing road infrastructure no disruption of existing native vegetation would be anticipated. Mucina and Rutherford (2006) list the

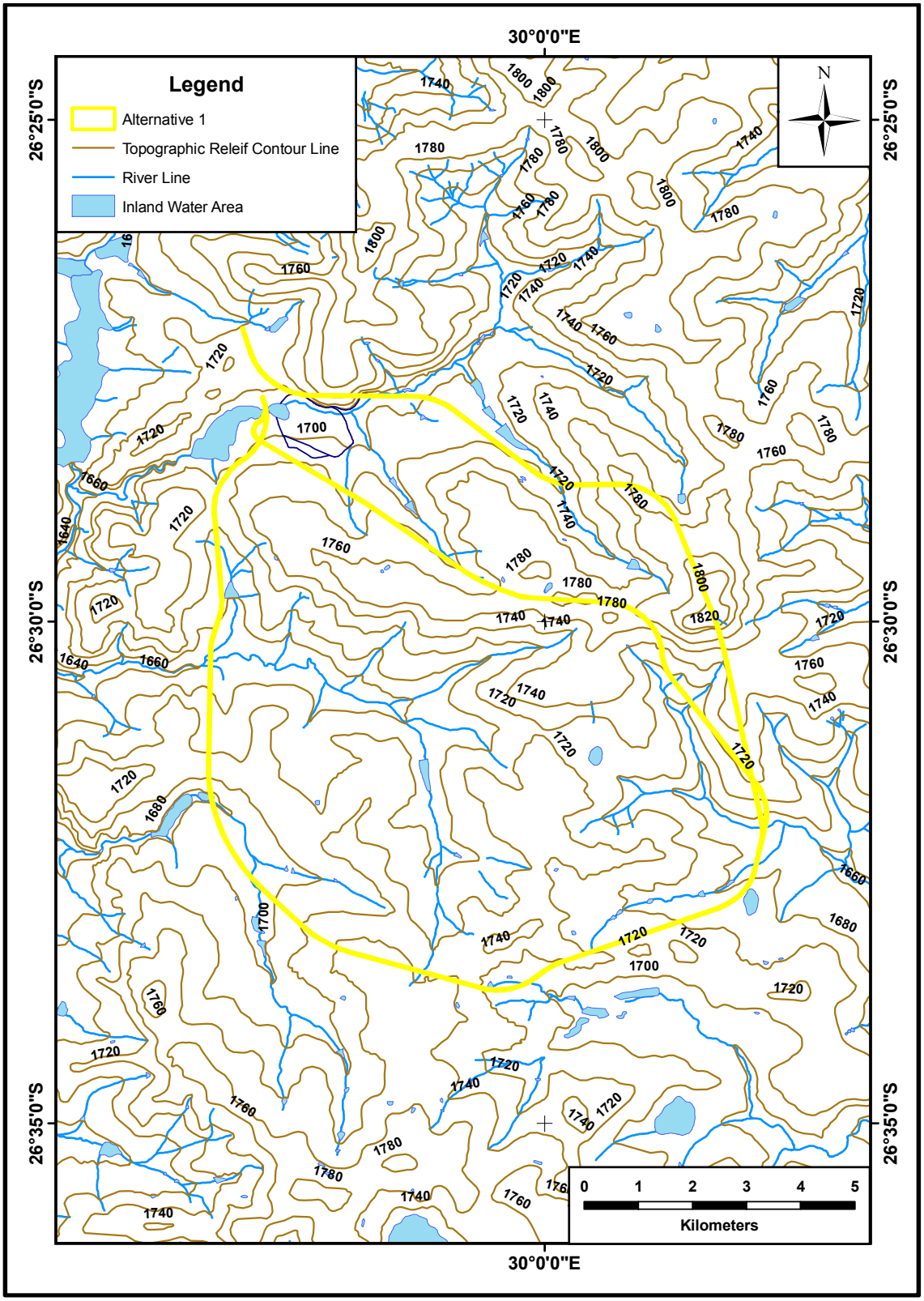

Figure 11: The environment of Alternative 1 and its surrounding environs. The topographic relief contour interval is 20 m.

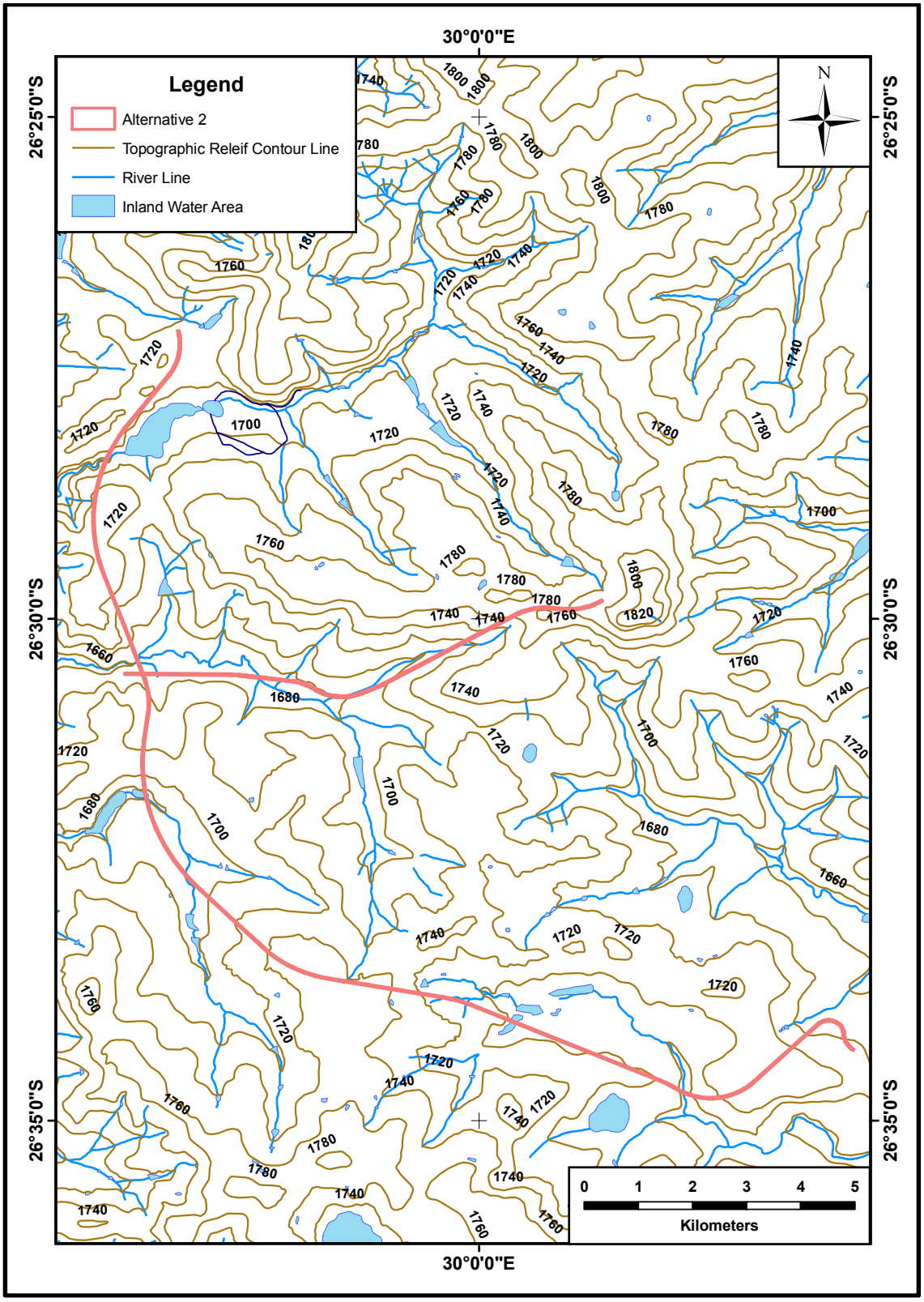

Figure 12: The environment of Alternative 2 and its surrounding environs. The topographic relief contour interval is 20 m.

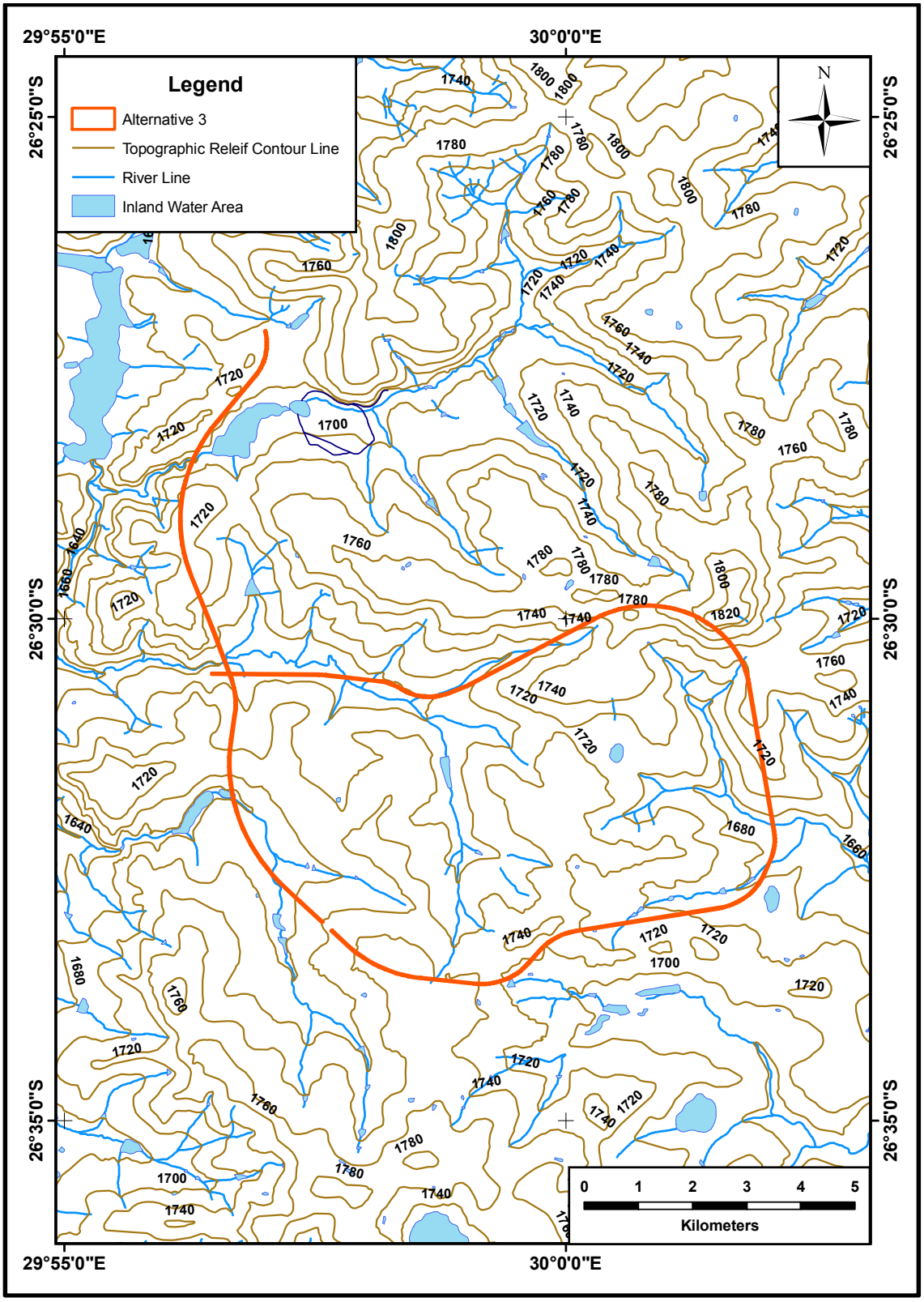

Figure 13: The environment of Alternative 3 and its surrounding environs. The topographic relief contour interval is 20 m.

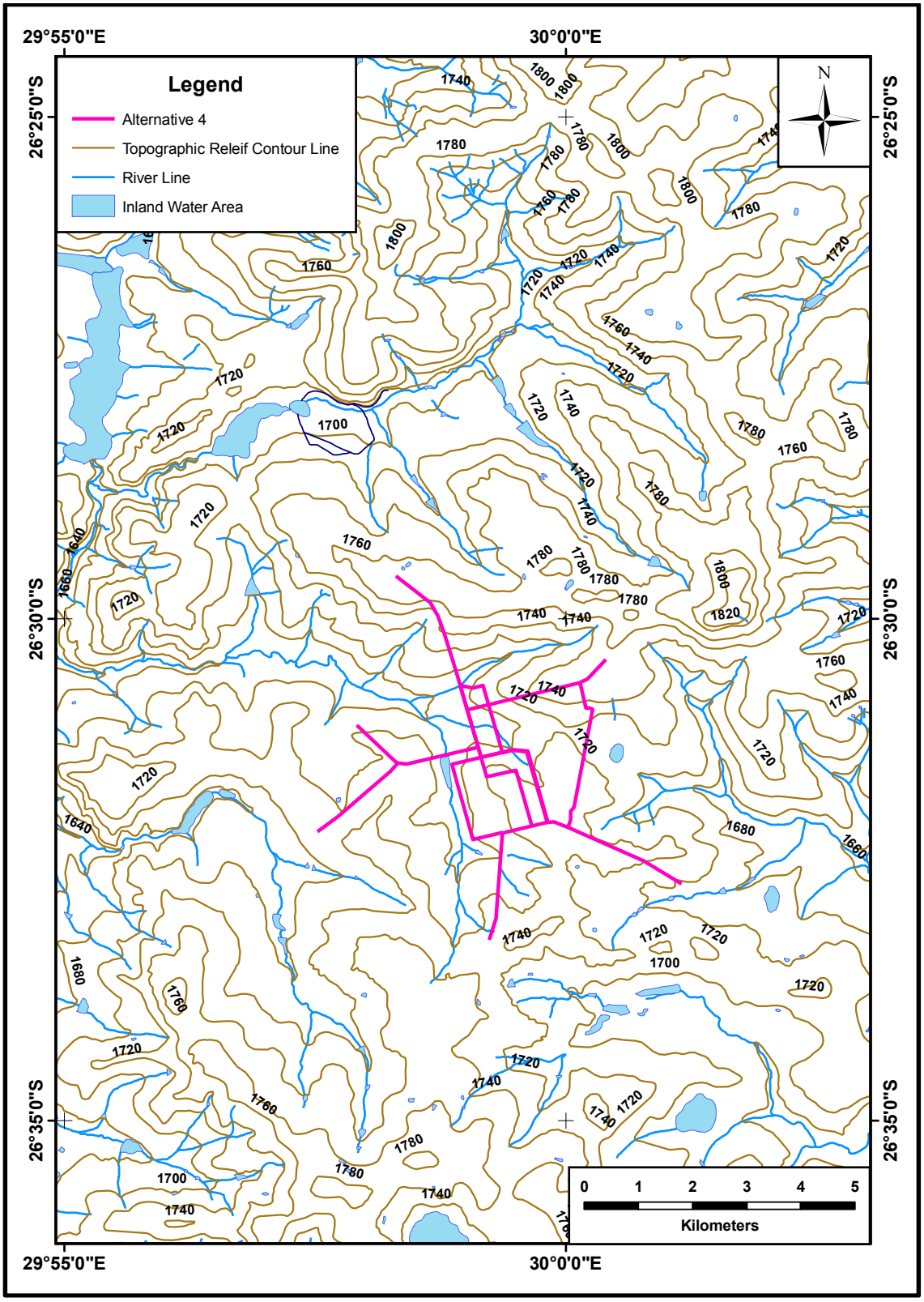

Figure 14: The environment of Alternative 4 and its surrounding environs. The topographic relief contour interval is 20 m.

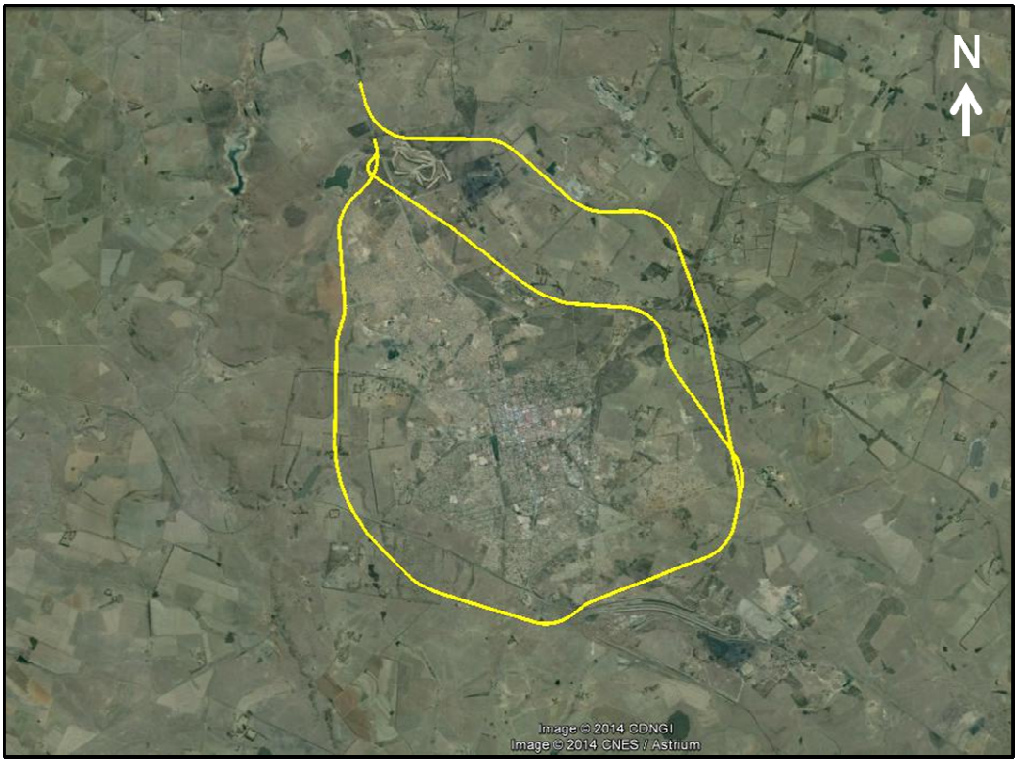

Figure 15: Google earth image of the location of Alternative 1. The entire route appears to be underlain by extensively ploughed agricultural land.

Figure 16: Google earth image of the location of Alternative 2. The entire route appears to be underlain by extensively ploughed agricultural land.

Figure 17: Google earth image of the location of Alternative 3. The entire route appears to be underlain by extensively ploughed agricultural land.

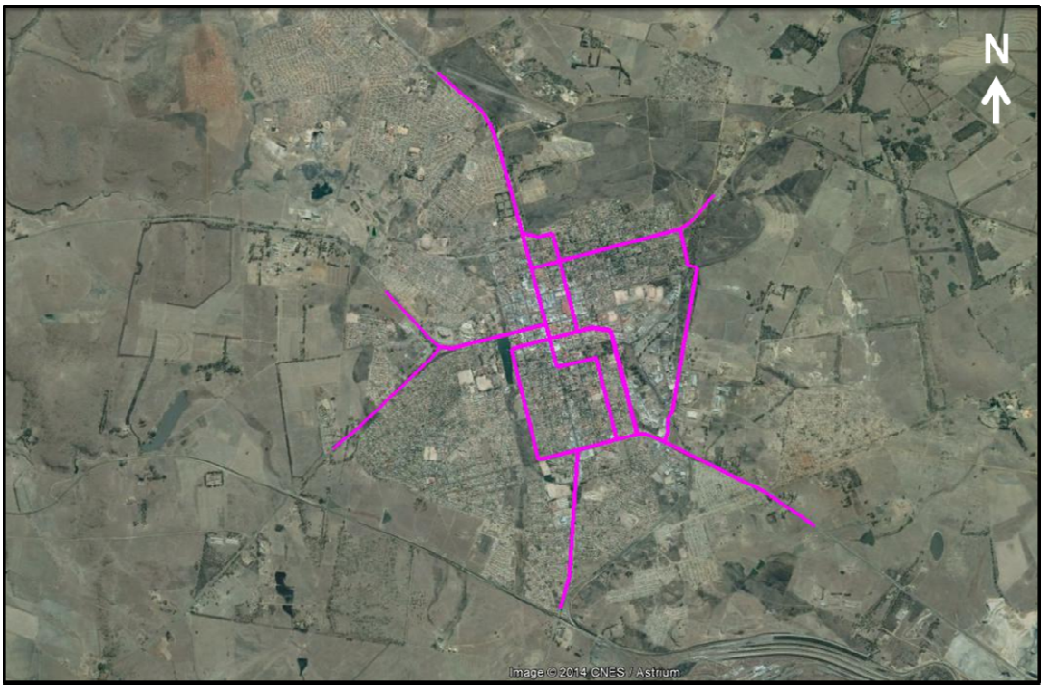

Figure 18: Google earth image of the location of Alternative 4. The entire route appears to be contained within the built environment of Ermelo or on the site of existing road infrastructure.

conservation status of the Eastern Highveld Grassland and Soweto Highveld Grassland veld types is listed as endangered, while the Amersfoort Highveld Clay Grassland was categorised as vulnerable.

The land surface underlying Alternatives 1-3 project area is almost completely utilised for agricultural cultivation (i.e., ploughed, Figures 15-17). The extensive ploughing of the land surface suggests that little (if any) of the original veld types remains extant and could be disturbed by construction of either Alternatives 1, 2 or 3.

The road system associated with Alternative 4 already exists, and is located within the built environment of Ermelo (Figure 18). The land use of the proposed Alternative 4 is characterised as urban development. No new destruction or degradation of any original environments would be anticipated should this alternative proceed.

9 IMPACT ASSESSMENT

The potential impact of the proposed ring road alternative road systems is categorised below according to the following criteria:-

9.1 Nature of Impact

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

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present and will be directly affected by the building or construction of the projects infrastructural elements it will potentially result in the irreversible damage or destruction of the fossil(s).
- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

9.2 Extent of impact

The possible extent of the impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil materials caused by the excavations and construction of the various roads constituting the alternative route that will eventually be selected. 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 new road infrastructure. Despite the large aerial extent of all of the proposed alternative routes, the extent of the area of potential impact for Alternatives 1-4 is, accordingly, categorised as **local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **permanent to long term**. This 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 route alternative eventually selected will be unavailable for scientific study for the life of the existence of those features (i.e., long term).

9.4 Probability of impact

The sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils. However, the occurrence of fossils within the geological record is in general erratic and the chance of impacting upon a fossil at any particular point within the Vryheid Formation is **moderate**. It is evident from Figures 15-17 that the entire extent of the Vryheid Formation strata which underlies Alternatives 1-3 has been utilised for agricultural production (i.e., it has been extensively ploughed). Accordingly, any fossil materials that may have been occurring at surface or within the shallow near-surface will have historically been either destroyed, damaged or moved (and their providence lost) as a result of the ploughing. Thus, the probability of negatively impacting upon scientifically useful fossils that may have located at the land surface or within the upper few tens of centimetres of the subsurface is now **negligible**. Alternative 4 is completely underlain by strata of the Vryheid Formation (Figure 18). However, Alternative 4 will result in the modification of existing roads and, as such, little to no disturbance of pristine land surface or environments would be expected. Accordingly, the probability of Alternative 4 negatively impacting upon scientifically useful fossils is categorised as **negligible**.

A large exposure of rocks of the Karoo Dolerite Suite is located to the south of Delmas and will be impacted by Alternatives 1, 3 and 4 (Figures 6, 8 and 9). The Karoo Dolerite

Suite is composed of dolerite, which is a hypabyssal intrusive igneous rock type which is formed by the crystallisation of magma at depth within the Earth's crust. Given the mode of genesis of dolerite there is nil chance of these rocks containing any fossils and the probability of the project causing any negative impact on the palaeontological heritage of these rocks is also **nil**.

9.5 Significance of the impact

Should the project 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. 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 delta top/fluvial/coal swamp environments that existed during the deposition of the Vryheid Formation provide an important window into the evolution of plant life during the Early Permian within the Main Karoo Basin 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 area are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**.

No fossil materials are expected to occur within the strata of the Karoo Dolerite Suite. The severity of any negative effects on the palaeontological heritage of this lithological unit is accordingly categorised as being **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 building or construction of project infrastructural elements the result will potentially be the irreversible damage or destruction of the fossil(s).

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

9.6 Severity / Benefit scale

The proposed project is categorised, herein, as being potentially **beneficial**. This classification is based on the intention that the project will provide a road route for travellers as an alternative to passing through the low speed, interrupted city traffic conditions of Delmas in Alternatives 1-3. If Alternative 4 is adopted the speed of passage through Delmas will also be increased. A potential benefit for Ermelo itself is the minimisation of high volumes of long distance haulage heavy truck numbers from the city traffic precincts (Alternatives 1-3), or an smooth traffic flow of these vehicles in the case of Alternative 4. The probability of a negative impact on the palaeontological heritage of the project area has been categorised as ranging between moderate to negligible (in the upper few tens of centimetres) for the Vryheid Formation and negligible for the Karoo Dolerite Suite.

The moderate to low likelihood of fossils being directly affected by the planned project must be weighed in conjunction with the severity of any negative impact that may result. Many fossil taxa are known from only a single fossil and, thus, any fossil material is potentially highly significant. This potential significance is highlighted by the fact that the sediments of the Vryheid Formation may contain important or unique examples of plant macrofossils of the Early Permian succession of the Main Karoo Basin. Thus, it is possible that there are fossils of scientific and cultural significance present within the sediments underlying the project area. Accordingly, the loss or damage to any single fossil or fossil locality can be potentially significant to the understanding of the fossil heritage of South Africa. As such, **although the likelihood of any disturbance of palaeontological materials is moderate (at worst case), the severity of any impact is potentially high**. The possibility of a negative impact on the palaeontological heritage of the area can, however, be minimised by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.

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

9.7 Status

Given the combination of factors discussed above, it is anticipated that as long as adequate mitigation processes are emplaced prior to commencement of the construction

phase little to no negative effect on the palaeontological heritage of the area is anticipated. As the proposed project would provide potential benefits to the residents of Ermelo by reducing traffic congestion caused by a reduction in the traffic volumes of large, long haul transport tucks within the towns traffic system. Similarly a positive outcome for long distance travellers should be provided by the project by speeding their travels either around, or through, Ermelo. Accordingly, the project is determined as having a **positive status** herein.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

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

10.1 Mitigation

The possibility exists of significant negative impact occurring to the fossil heritage of the Vryheid Formation resulting from excavations associated with the construction of Alternatives 1-3. However inspection of Google earth imagery of the project area that the entire land surface underlain by the Vryheid Formation that will be impacted by Alternatives 1-3 has been severely impacted by ploughing activities; with the result that any fossils that may have been present (and within the upper few tens of centimetres of the land surface) will have been either destroyed, damaged or moved and their prominence lost. As such, little would be gained by a thorough field investigation of the final project area which is underlain by the Vryheid Formation by a palaeontologist prior to the commencement of construction. However, it is anticipated that the road construction process will result in excavations that will disrupt the land surface below the depth of the ploughed soils. Accordingly, it is recommended that a close examination of all excavations and new road cuttings be made while they are occurring. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as per legislation outlined in Section 3.3 of this report).

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. Clearly, for this recommendation to be adequately complied with a palaeontologist should be retained by the management of the project to periodically inspect all excavations as they are being performed.

Should scientifically or culturally significant fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (under permit from SAHRA) by a palaeontologist and the resultant material being lodged with an

appropriately permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

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 generally low. However, any fossil material that may be contained within the strata underlying the project area is potentially of the high 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 necessarily significant culturally or 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. In particular, the discussion of the geological units present within the project area (and as such the basis of understanding the fossiliferous potential of the area) was derived from the published 1:250 000 geological map of the area). The accuracy of 1:250 000 geological maps is often variable; some areas being compiled from air photo interpretation or remote sensing procedures. The possibility of the presence of additional geological units being present within the project area cannot be disregarded.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of the proposed construction four alternative ring road routes (named Alternatives 1-4 herein) proposed to be located within Ermelo and its environs. This desktop Palaeontological Impact Assessment Report will form part of a comprehensive Heritage Impact Assessment Report that will in turn speak to a larger Environmental 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.

The aerial extent of the potential project infrastructure is large, measuring a maximum extent of approximately 18 km from northwest to south east and approximately 10 km southwest to northeast. However, the majority of this area will be unaffected by the proposed constructions. This said, the length of each of the road systems required for each of Alternatives 1-3 is large (Alternative 1 = 35 km, Alternative 2 = 31 km and Alternative 3 = 34 km) and the width of the developments will be approximately 80 m (including verges), and the cumulative area that will be affected in each of these three alternatives remains large. The road system associated with Alternative 4 already exists and is restricted to the present built environment of Delmas. Despite the extensive aerial extents of each of the four alternative routes, any negative impacts to the palaeontological heritage of the region will be restricted to the location of any road construction; as such, the extent of the potential impacts are characterised as local.

The rocks of two geological units underlie the project area; these being the Permian sediments of the Vryheid Formation and the Jurassic igneous rocks of the Jurassic Karoo Dolerite Suite. The Vryheid Formation is potentially fossiliferous, but no fossil materials are known to occur within the unit within the environs of the project area. The rocks of the Karoo Dolerite Suite are considered to be non-fossiliferous.

Of the geological units that underlie the project area only the Vryheid Formation is potentially fossiliferous. In general the potential for any negative impact on fossil materials contained within the unit is classified as moderate. It is anticipated that the effects of any road construction will be limited to the upper few (1-2 m) of the land surface. Where road cuttings are required to be built this may result in a deeper disruption. However, over the majority of the proposed Alternatives 1-3 the upper-most few tens of centimetres of the land surface has been historically disturbed by the effects of ploughing and the potential for any negative impact has been reduced in this interval to being negligible.

Despite the moderate to negligible chances of any negative impact being caused by the project any fossils that may be anticipated to be present within these units are potentially highly significant to the cultural and scientific heritage of South Africa and the

world. Any damage or loss of provenance (due to accidental relocation) that occurs to such fossil material during the excavation and construction phase of the project would be permanent and irreversible. Any fossil materials that remain undiscovered after the construction of the project and which are located beneath the maximum depth of the anticipated excavations will only be negatively affected in so far as they will be unavailable for scientific study for the life expectancy of the infrastructural elements that comprise the project.

The potential negative impact to the palaeontological heritage of the area can be minimised by the implementation of appropriate mitigation processes (see Section 13 below). A secondary advantage of the implementation of these mitigation measures would be that any new fossil materials located could prove to have a positive effect on the understanding of the fossil record of South Africa and positively affect the palaeontological heritage of the country.

The social benefits of the project have been classified as beneficial, herein, as the project aims to benefit the passage of travellers through the Ermelo area, as well as reducing the negative traffic implications caused by high traffic volumes of large, long distance transport trucks passing through Ermelo. As such, **this desktop study has not identified any palaeontological reason to prejudice the progression of any of Alternatives 1, 2, 3 or 4, subject to the mitigation recommendations listed below being put in place**.

13 RECOMMENDATIONS

The following recommendations are made to ensure that any potential negative impacts resulting from the proposed project upon the palaeontological heritage of the area are minimised.

- Should any excavations be undertaken on parts of the project area that are underlain by strata of the Vryheid Formation regular inspections are to be made of those excavations to ensure that no fossil materials are being impacted.
- That the indicated regular inspections of any excavations should be undertaken by a palaeontologist.
- Should any fossil materials be identified in the excavations that portion of the excavations must be halted in that area (see Section 3.3 herein) until such time as their significance has been assessed by a palaeontologist. SAHRA must be notified of the fossil finds.
- Should scientifically or culturally significant fossil material exist within the project area and be identified in any excavations any 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.

14 REFERENCES

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

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

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

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

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

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

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

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

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

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

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

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