DESKTOP PALAEONTOLOGICAL IMPACT ASSESSMENT REPORT FOR A PROPOSED ADDITIONAL 66 TO 132 KV POWER LINE FOR THE AUTHORISED SPRINGFONTEIN WIND ENERGY FACILITY, FREE STATE PROVINCE

Prepared for:
Heritage Contracts and Archaeological Consulting CC

On Behalf of:
South Africa Mainstream Renewable Power Springfontein (Pty) Ltd

Prepared By:
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EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Springfontein (Pty) Ltd has received environmental authorisation for the Springfontein Wind Energy Facility located south-west of Springfontein in the Free State. The current authorisation approves a loop in and loop out 132 kV power line up to 500 m in length to tie into the existing Besembos-Signal 132 kV power line which traverses the wind energy facility site (on the remaining extent of Farm Stock Port 283). This grid connection is still an option. However, due to capacity constraints on the Eskom transmission infrastructure which traverses the site, Mainstream would like to add an additional grid connection alternative to be authorised to the development. As such Mainstream have proposed a number of alternatives to connect to the Eskom Oranjekrag/Springfontein 66 kV line which runs 5-7 km east of the on-site substation of the wind farm. This study forms part of the Basic Assessment process required for environmental authorisation of the proposed additional power line.

Seven (7) alternative routes are proposed for the power line (named Alternatives 1, 1a, 2, 2a, 3, 4 and 5). These alternative routes all originate at the same point on the farm Stock Port 283 RE and variously extent across the farms Prior Grange 282 RE and Kiel 37 RE. The project area is located approximately 12 km southwest of Springfontein in the Bethulie Magisterial District, Kopanong Local Municipality, Free State Province (Figure 1).

South Africa Mainstream Renewable Power Springfontein (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake a Basic Assessment Process and compile an Environmental Management Programme (EMPr). Savannah Environmental (Pty) Ltd appointed Heritage Contracts and Archaeological Consulting CC to compile a Heritage Impact Assessment Report that will be used in the compilation of the EMPr. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to conduct a desktop Palaeontological Heritage Impact Assessment Study that will form a component of the wider Heritage Impact Assessment Report.

Three stratigraphic units are identified as underlying the project site, these being (in descending stratigraphic order):-

1. Cenozoic alluvium
2. Karoo Dolerite Suite
3. Adelaide Subgroup, Karoo Super Group

The sediments of the Adelaide Subgroup and the Cenozoic alluvium are potentially fossiliferous and are known to contain fossils elsewhere in the Karoo. In particular the rocks of the Adelaide Subgroup in the project area contain vertebrate fossils of the *Cistecephalus* Assemblage Zone which are of world significance for documenting and early portion of the evolutionary transition between reptiles and mammals.

The probability of the project negatively impacting on the palaeontological heritage of South Africa is assessed as improbable. However, given the scientific importance of the fossils forming the *Cistecephalus* Assemblage Zone the significance of any negative impact would potentially be very high. Any damage to the fossil materials present within the project area will be irreversible, and permanent to long term. A number of mitigation procedures are outlined, that if enacted will minimise the potential for any negative impact to the areas palaeontological heritage. It is also possible that the application of these mitigation procedures may result in the finding of new fossil materials. Indeed, should such previously new fossil material be found it may prove to result in a positive impact on the palaeontological heritage of South Africa.

Should the outlined damage mitigation procedures be implemented no palaeontological reason was identified that should negatively impact on the proposed additional power line and the project status is assessed as being beneficial.

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1 INTRODUCTION

South Africa Mainstream Renewable Power Springfontein (Pty) Ltd has proposed the establishment of an additional 132 kV power line as a alternative option to connect the previously environmentally authorised Springfontein Wind Energy Facility to the national power grid. The current authorisation approves a loop in and loop out 132 kV power line up to 500 m in length to tie into the existing Besembos-Signal 132 kV power line which traverses the wind energy facility site (on the remaining extent of Farm Stock Port 283). This grid connection is still an option. However, due to capacity constraints on the Eskom transmission infrastructure which traverses the site, Mainstream would like to add an additional grid connection alternative to be authorised to the development.

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2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

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

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.

- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

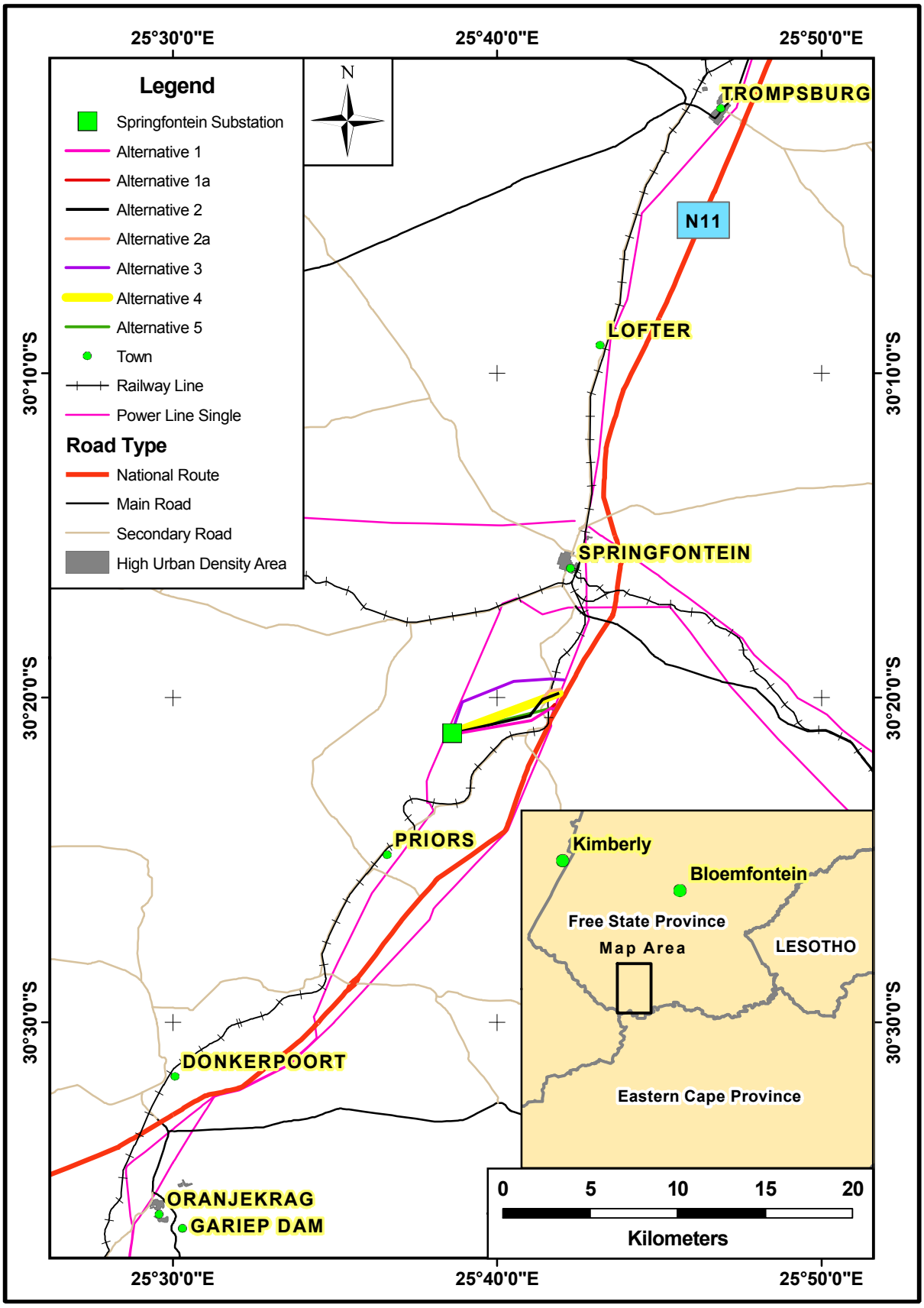

Figure 1: Location map showing the position of the proposed power line alternative routes.

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 artifacts, 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).

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 RELEVANT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological

Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP), and is a member of the Palaeontological Society of South African and the Geological Society of South Africa.

5 GEOLOGY

Figure 2 shows that the project area is primarily underlain by Late Permian sediments of the Adelaide Subgroup, Karoo Supergroup. It is evident from Figure 3 that a narrow, arcuate expanse of Cenozoic alluvium is also present within the project area and that several of the power line alternative routes traverse these exposures. There are also exposures of rocks of the Karoo Dolerite Suite that underlie a number of the power line route alternatives (Figure 3).

A brief description of the stratigraphic units identified during the field visit and their potential palaeontological content are provided below, in order of increasing geological age.

5.1 Adelaide Subgroup

5.1.1 Geology

The Adelaide Subgroup consists of greenish or blue grey and greyish-red mudstones and sandstones (South African Committee for Stratigraphy, 1980; pp. 538-539). The Adelaide Subgroup is differentiated into two distinct stratigraphic sequences which are located either side of the line of longitude of 24° east. To the east of that dividing line the Adelaide Subgroup consists of (in order of decreasing stratigraphic age) the Koonap, Middelton and Balfour Formations. To the west of 24° east the Adelaide subgroup is subdivided into a lower Abrahamskraal and an upper Teekloof Formations. The project area lies at approximately 25° 40’ east and so forms part of the eastern succession (Johnson *et al*., 2006). Figure 4 shows that the project area lays within the aerial extent of the vertebrate fossil-based *Cistecephalus* Assemblage Zone. Given that the project site falls within the eastern succession this would indicate that the rocks underlying the project area are either those of the uppermost part of the Middelton Formation or the lowermost part of the Balfour Formation (Smith and Keyser, 1995).

5.1.2 Palaeontological potential

Vertebrate fossils of the *Cistecephalus* Assemblage Zone are mostly preserved in the interchannel mudstones. They are usually found as dispersed isolated fossils, but isolated skulls are relatively abundant within particular areas and fossil materials have proven to be present in great abundance in narrow intervals at the top of the biozone in the southern Karoo (Smith and Keyser, 1995).

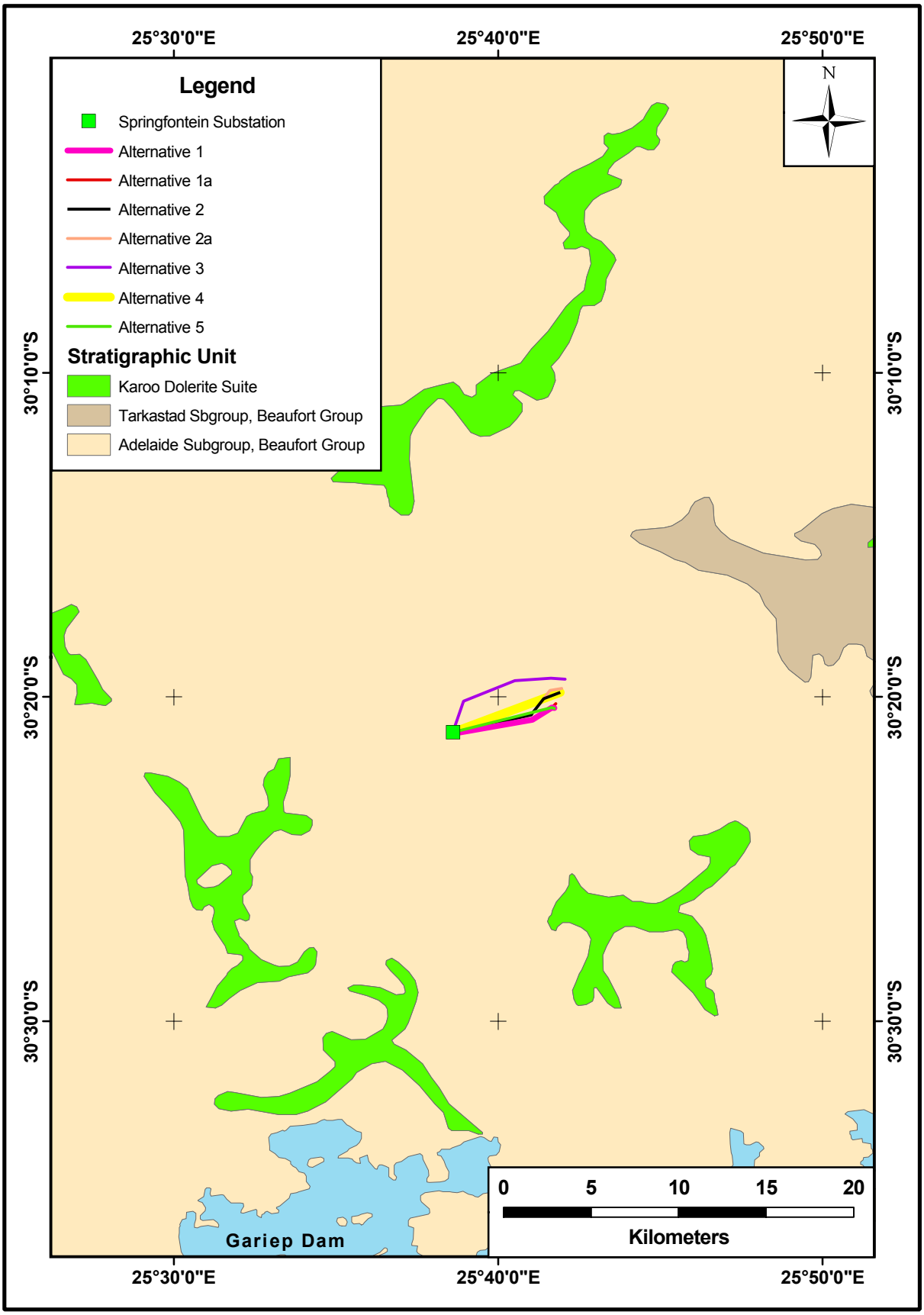

Figure 2: Generalised geological map of the project area and its surrounding environs.

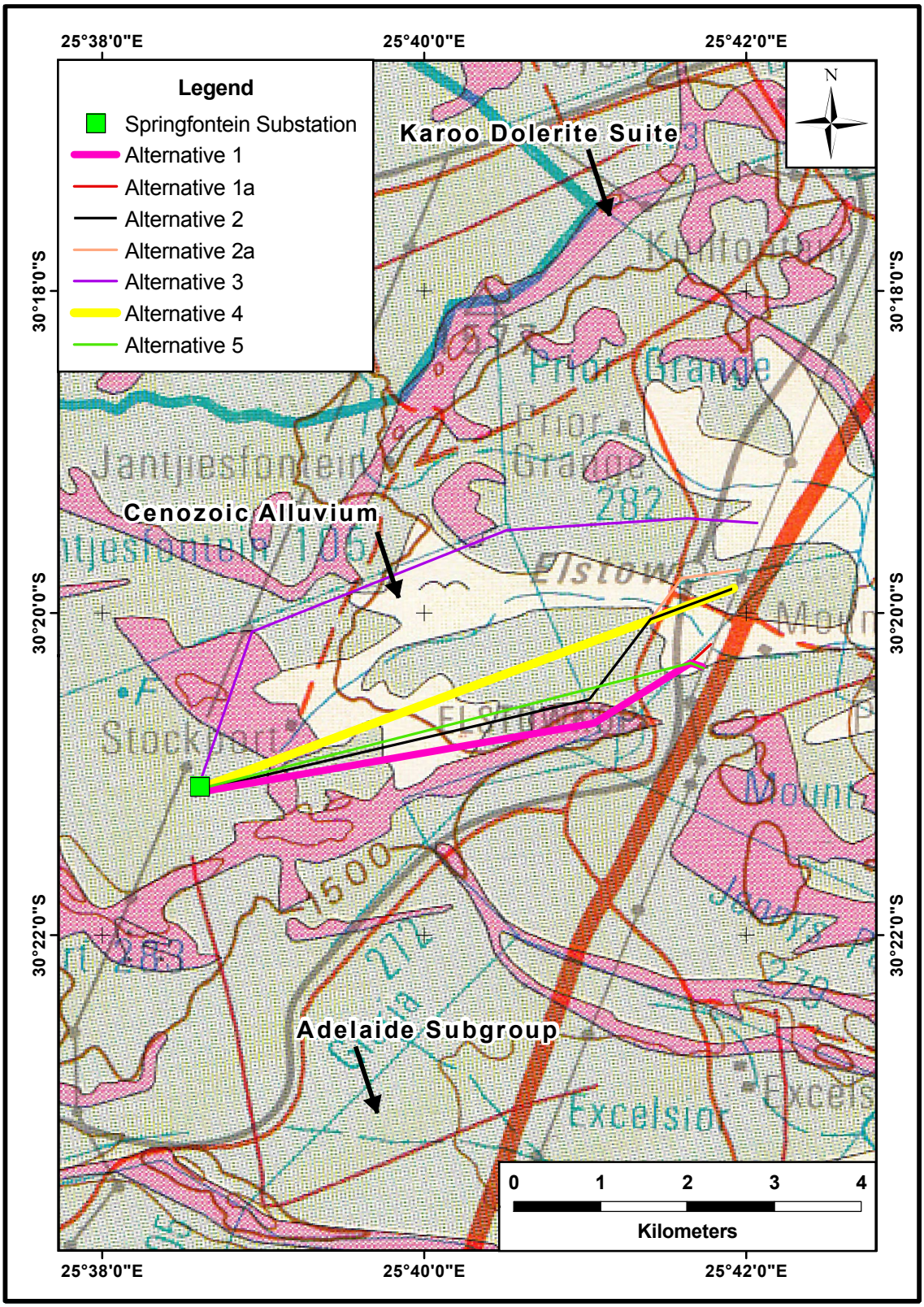

Figure 3: Detailed geological map of the project area showing the location of the seven alternative power line locations. Shown is the large, arcuate area of Cenozoic alluvium present beneath all of the power line location options (1:250 000 Geological Sheet 3024 Colesburg, 1997).

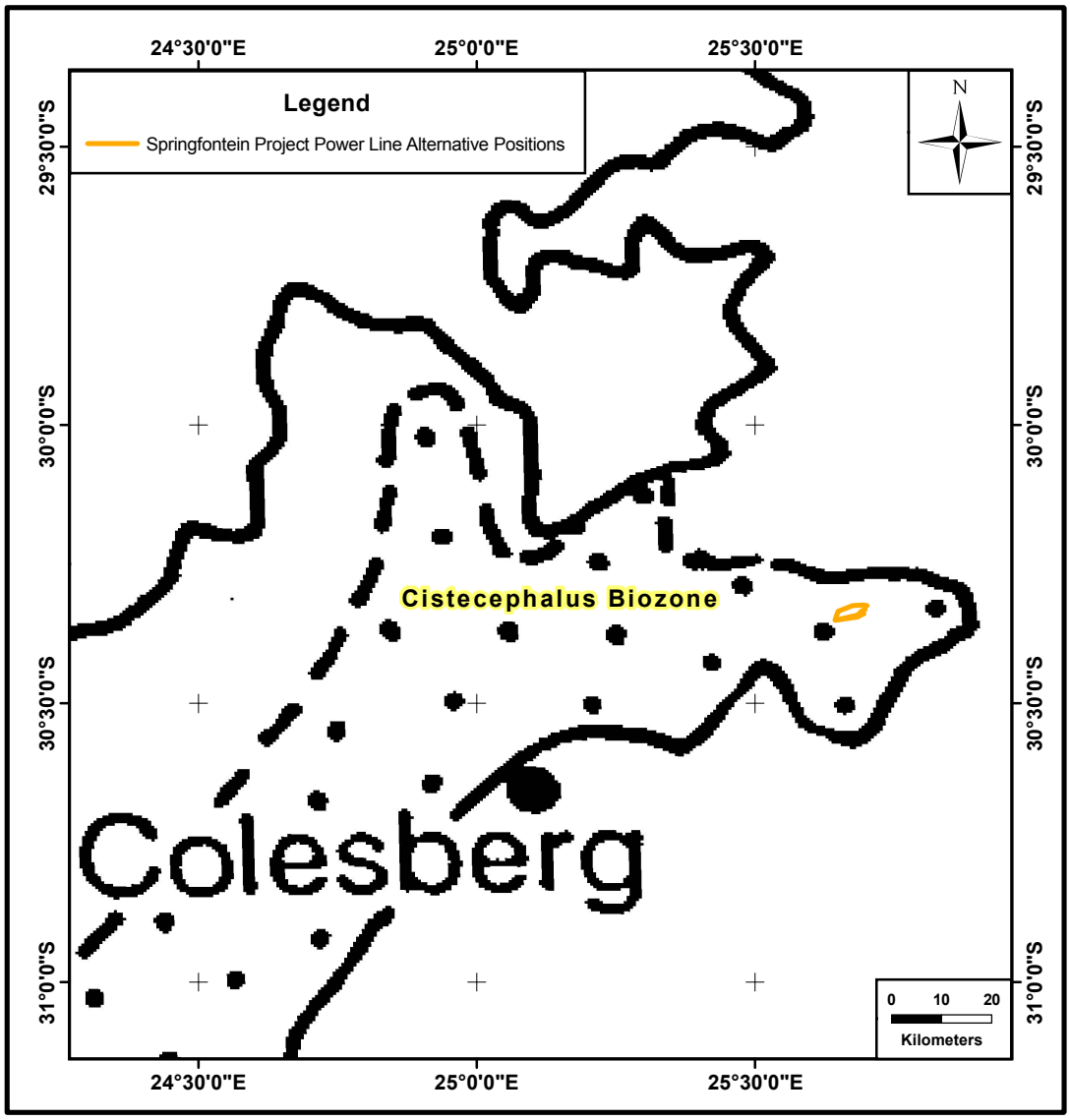

Figure 4: Location of the proposed power line alternative locations within the aerial extent of the *Cistecephalus* Assemblage Zone (stippled) within southern South Africa.

The fluvial lacustrine sediments of the rocks underlying the project area form part of the faunally diverse *Cistecephalus* Assemblage Zone (Figure 4). As such the rocks underlying the project area may be expected to contain vertebrate fossils belonging to the reptiles Dicynodontia (*Aulacephalodon*, *Dicynodon*, *Diictodon*, *Dinanomodon*, *Emydops*, *Oudenodon*, *Endothiodon*, *Cistecephalus*, *Rachiocephalus*, and *Pristerodon*), Gorgonopsida (*Gorgonops*, *Cyonosaurus*, *Cielandina*, *Cyonosaurus*, *Dinogorgon*, *Lycaenops*, *Prorubidgea*, *Rubidgea* and *Arctognathus*), Therocephalia (*Ictidosuchops* and *Ictidosuchoides*), Captorhinida (*Anthodon*, *Owenetta* and *Pareiasaurus*), amphibians (*Rhinesuchus*) and fish (*Athestonia* and *Namaicthys*) (Smith and Keyser, 1995).

The plant macrofossil assemblages of the stratigraphic succession containing the *Cistecephalus* Zone are sparse and depauperate compared to the contemperaneous

vertebrate fossil assemblages. Bamford (2004) records on the presence of the wood genera *Agathoxylon* and *Australoxylon*).

5.2 Karoo Dolerite Suite

5.2.1 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). Figure 3 also shows that the western portions of all power line alternatives 1, 2, 3 and 5 traverse exposures of rocks of the Karoo Dolerite Suite.

5.2.2 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.

5.3 Cenozoic alluvium

5.3.1 Geology

It is evident from Figure 3 that a narrow, arcuate expanse of Cenozoic alluvium is present within the region of all proposed alternative power line routes. The thickness of the sequence and lithologies present within this alluvium succession is uncertain. Figure 3 shows that the central portions of all alternative routes as well as parts of the eastern portions of power line alternative routes 1, 1a, 2, 4 and 5 traverse exposures of the alluvium cover.

5.3.2 Palaeontological potential

Cenozoic age palaeontological sites are occasionally identified in alluvial terraces and dongas throughout the Karoo. It may expected that large mammal bones, dentition, horn cores, micromammal bones and fresh water molluscs may be identified within this part of the stratigraphic sequence.

6 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The area containing all the power line alternative route options is large, extending approximately 6 km southwest to north east and 2.5 km at its widest point north to south (Figure 5). However, the area that will eventually be affected will be considerably smaller, being constrained to the length of one of the power line alternatives and a servitude width of 36 m. The various power line options all terminate against an approximately north-south oriented power line that forms the eastern boundary of the project area reported upon herein. An approximately north-south oriented railway line runs sub-parallel to, and just to the west of, the eastern power line (Figure 1).

The area over which all alternative routes traverse is topographically a featureless, flat land surface (Figures 6 and 7). A well-developed ephemeral drainage line cross-cuts the centre of the project area extending in a northeast direction from just north of the Springfontein substation (Figures 6 and 7). No other significant drainage features are present within the area. The entire site is covered with low bushes and grasses of the Xhariep Karroid Grassland veld type (Mucina and Rutherford, 2006). The Xhariep Karroid Grassland veld type (Figure 8) has a conservation status of least threatened (Mucina and Rutherford, 2006). The predominant agricultural land use in this portion of South Africa is for grazing and game farming.

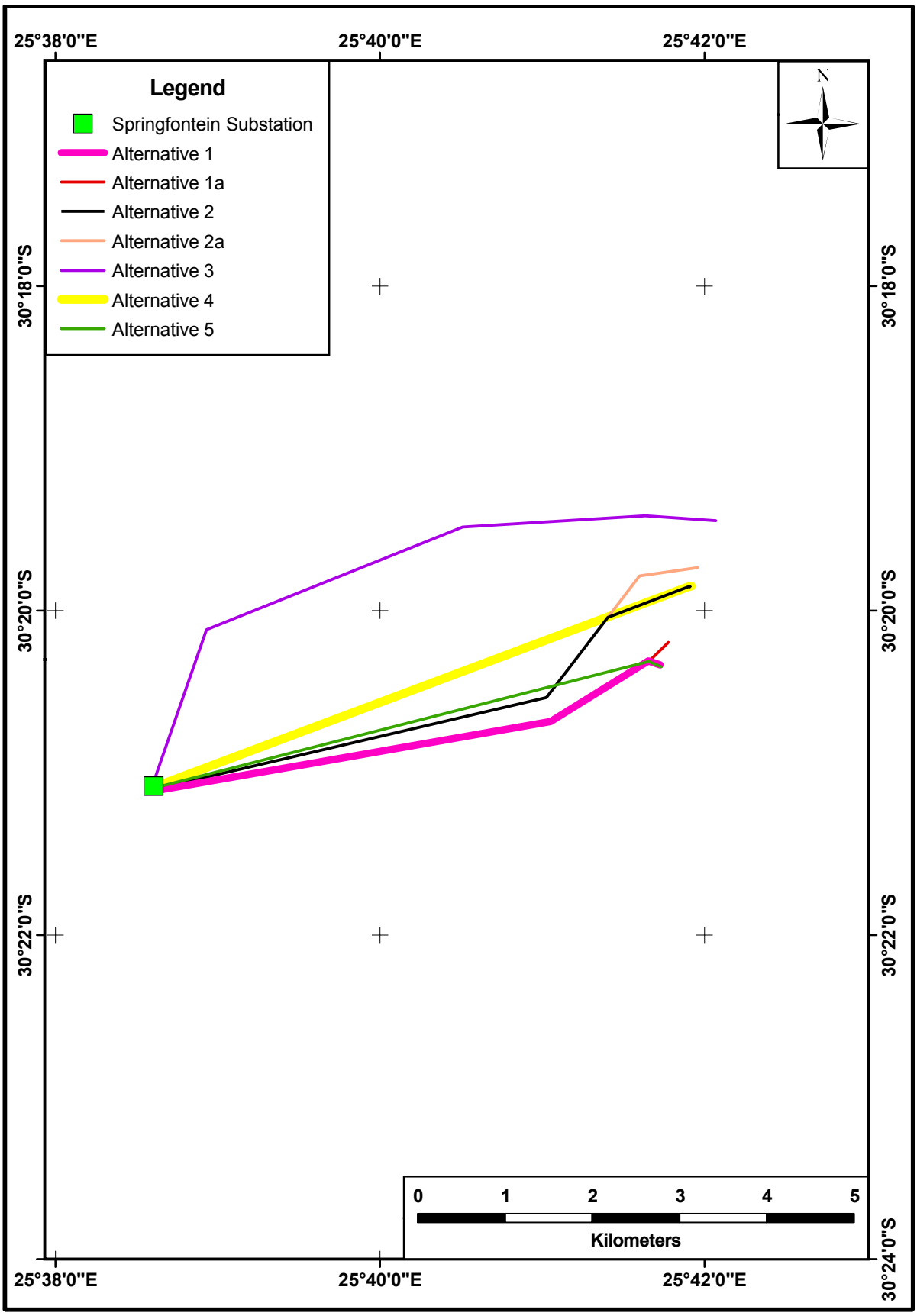

Figure 5: Close up view of the location of the seven (7) power line alternative routes.

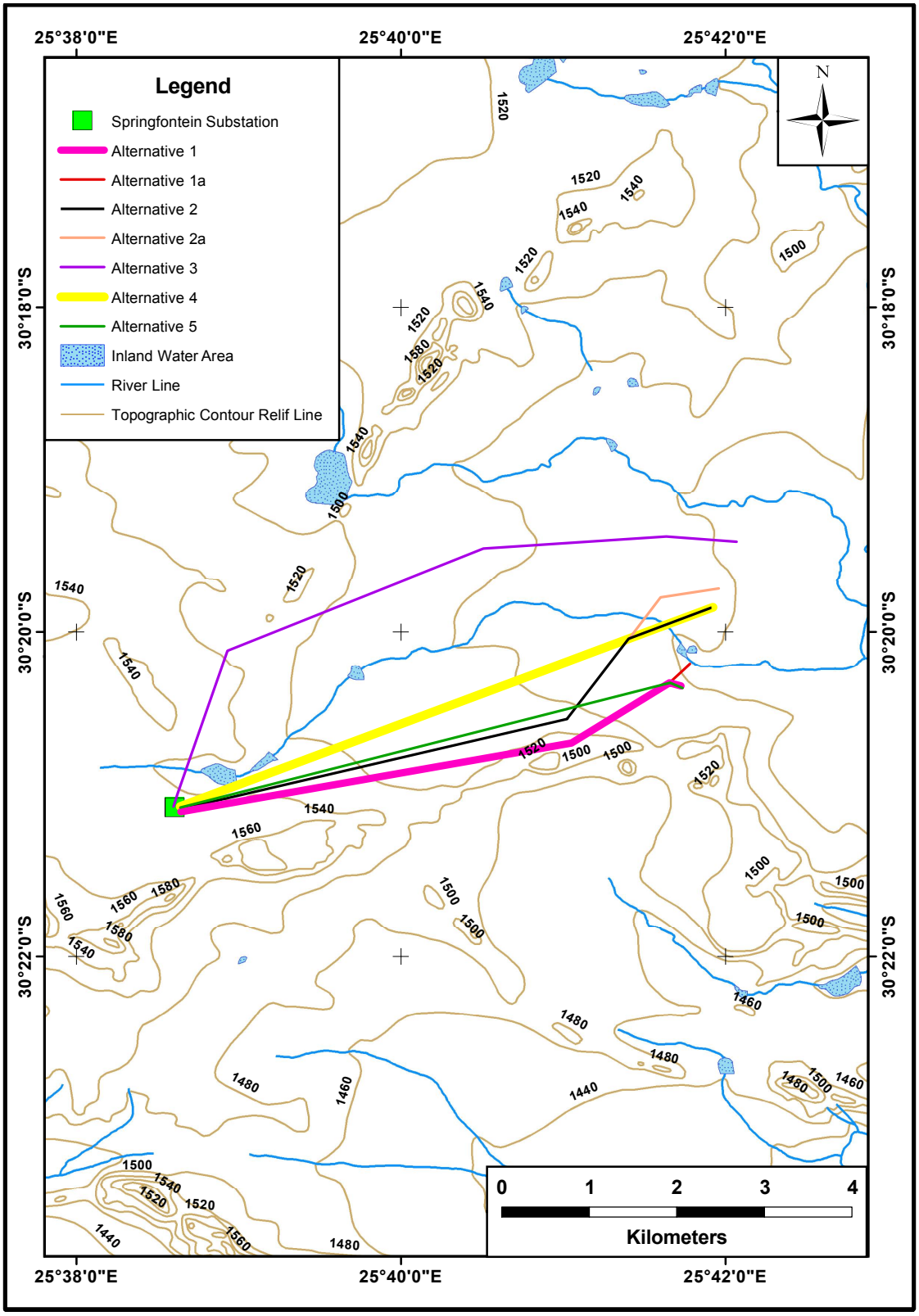

Figure 6: Map of the project area and its immediate environs. It is evident that the land surface is relatively flat and featureless (note: the topographic contour interval is 20 m). A single arcuate ephemeral river line traverses the centre of the area.

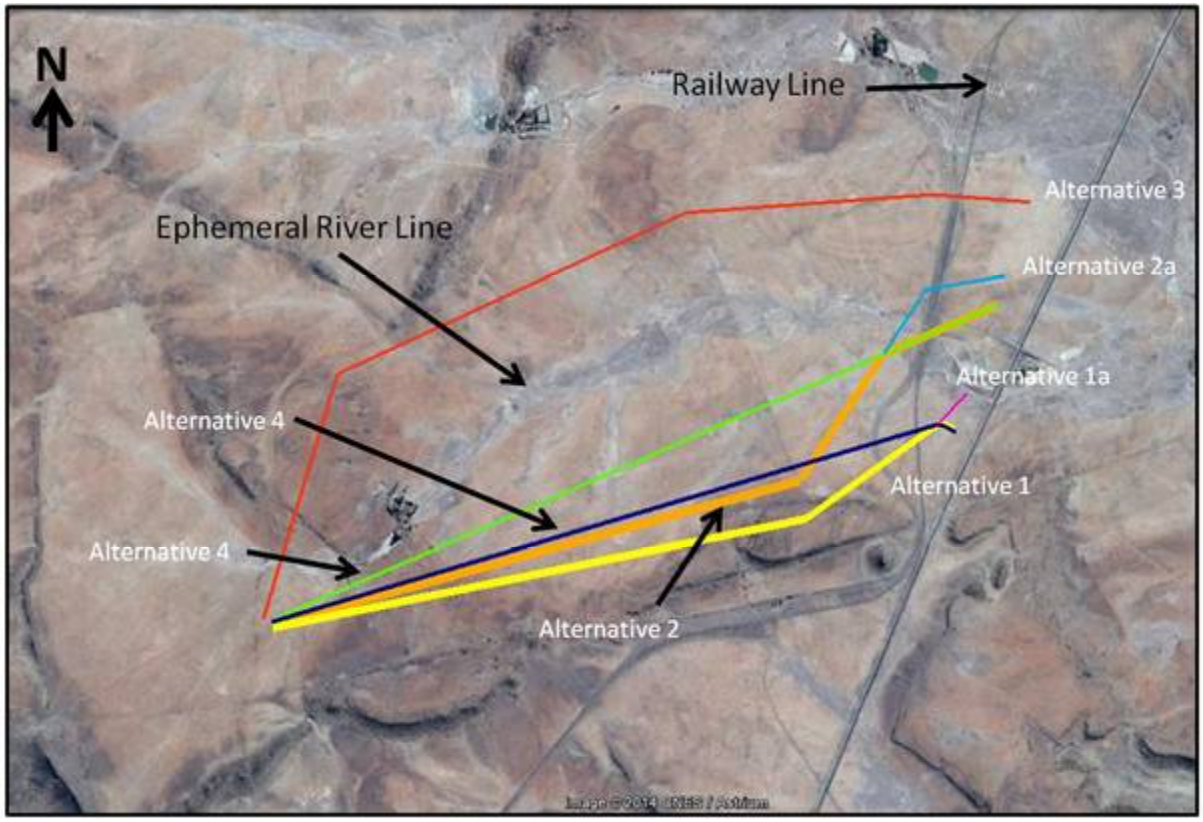

Figure 7: Google Earth image of the project area and its immediate environs showing the location of the seven (7) power line alternative locations. The area is flat and featureless, except for an arcuate ephemeral river line that cross-cuts the region. The power line alternative routes terminate against an existing power line at their eastern end.

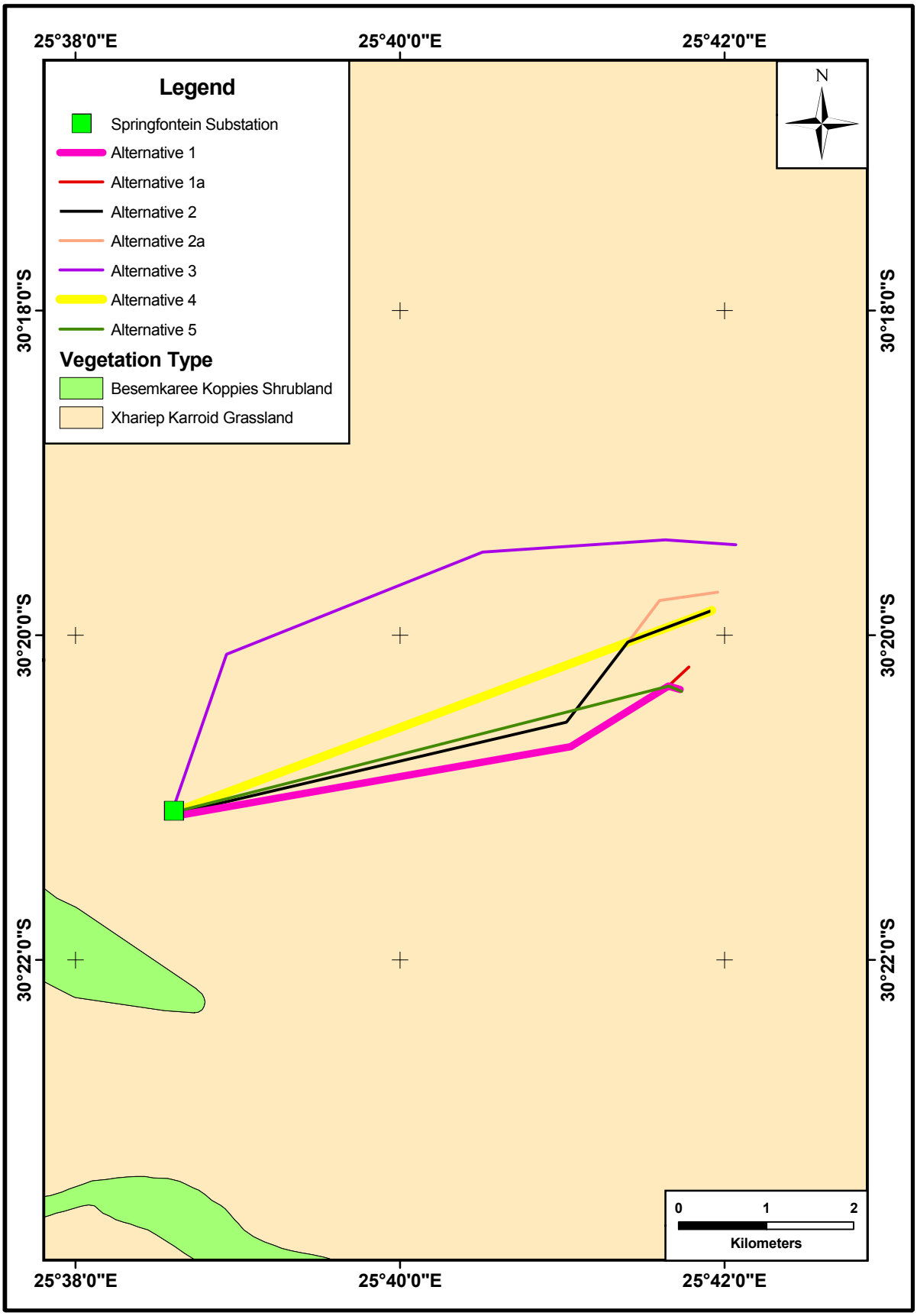

Figure 8: Map showing the distribution of the veld types present within the project area and its immediate environs (after Mucina and Rutherford, 2006).

7 OVERVIEW OF SCOPE OF THE PROJECT AND POTENTIAL NEGATIVE EFFECTS

The project development, as envisaged, will consist of a single 66 to 132 kV power line that will extend across the project area from the Springfontein substation in the west to the existing north-south oriented power line in the east. There will be a 36 m wide servitude associated with the power line.

Infrastructure elements associated with the power line that may cause possible source of negative impact on the palaeontological heritage of the area will be the foundations of the power line pylons and any road that is associated with the servitude. It is anticipated, for the purposes of this report, that any road associated with the servitude will be a twin spoor dirt track. Such a track will only result in disturbance of the superficial land surface. The depth of disturbance required for the construction of each power line pylon is unknown to the author at the time of preparation of this report; it is probable that the maximum depth of disturbance of the land surface should not exceed 2 m. The number or power line pylons that will be required for this project cannot be determined until the final route is selected, thus the cumulative impact of the project cannot be quantified with precision.

8 IMPACT ASSESSMENT

The potential impact of the proposed expansion of the South Africa Mainstream Renewable Energy Springfontein (Pty) Ltd's power line infrastructure associated with the Springfontein electrical substation is categorised below according to the following criteria:-

8.1 Nature of Impact

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

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

- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

8.2 Extent of impact

The potential negative effects posed by this project on the palaeontological heritage of South Africa is restricted to the damage, destruction or covering of fossil material caused by the construction of the necessary infrastructure elements anticipated as forming part of the project (i.e., the power line pylons and a servitude road). Thus, the **extent of the area of impact is categorised as local, but the area is large (= a scoring value of 3)** (i.e., restricted to the project site).

8.3 Duration of impact

The anticipated duration of any negative impact that may be caused by the proposed project is assessed as potentially **long term to permanent**. This is assessment is based on the fact that, in the absence of mitigation procedures (should fossil material be present within the area to be affected), the damage or destruction of any palaeontological materials will be **permanent (= a scoring value of 5)**. Similarly, any fossil materials that exist below the power line pylon foundations and any servitude road will be unavailable for scientific study for the life of the existence of those features (i.e. **long term**).

8.4 Probability of impact

It is pertinent to realise that fossils (particularly vertebrate fossils) are generally scarce and sporadic in their occurrence in the geological record. It was indicated, in Section 5.1.2 above that there are thin stratigraphic layers within the upper-most part of the strata containing the *Cistecephalus* Assemblage Zone where fossils occur in great abundance, but to some extent this is only in comparison to most other portions of the geological record. The probability of any development affecting a fossil at any particular point on the land surface underlying the route of the power line alternative that will eventually be selected is assessed as low and, as such, **the probability of any negative impact on the palaeontological heritage of the area occurring is improbable (low likelihood= a scoring value of 2)**.

8.5 Significance of impact

The rocks of the Karoo Supergroup are known as possibly the most significant stratigraphic section in the world for documenting the evolutionary transition from reptiles to mammals. Thus, the fossils of the Karoo-age sequence are an important component of the world's palaeontological and scientific heritage. The fossils of the

Cistecephalus Assemblage Zone document, in part, the early stages of that evolutionary transition and it is evident from Section 5.1.2 above that the rocks hosting this biostratigraphic interval unit potentially contain a rich and diverse vertebrate fauna. Similarly, the possibility exists of scientifically significant fossils also being present within the Cenozoic alluvium present which will be impacted by all possible route alternatives.

The scientific and cultural significance of individual fossils 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 position 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.

Thus, while the probability of a negative impact on the palaeontological heritage contained within the sedimentary strata underlying the project area is categorised as improbable, the significance of any negative impact posed by the project on the palaeontological heritage is categorised as potentially high if appropriate mitigation procedures are put into place.

The significance of the impacts resulting from each of the seven alternative power line alternative routes is the same and is calculated as follows:

S = (E+D+M)P

Where

S = Significance
E = Extent
D = Duration
M = Magnitude
P = Probability

Accordingly, the significance of any impacts posed by the three solar park projects upon the palaeontological heritage of the area is calculated as being,

Unmitigated
S = (3+5+10)2
S = 36

The calculated significance value of 36 equates to a Significance Weighting of **Medium** (i.e., 30-60 points) if no mitigation processes are performed.

Mitigated
S = (3+5+2)1
S = 9

The calculated significance value of 9 equates to a Significance Weighting of **Low** (i.e., <30 points) if mitigation processes are performed.

8.6 Severity / Benefit scale

The proposed project is categorised, herein, as being **beneficial**. This classification implies that the project will provide a long term benefit to the community in terms of the provision of renewable electricity to an increasingly stressed national power grid. This positive benefit will continue throughout the life of the project. The probability of a negative impact on the palaeontological heritage of the project area have been categorised as improbable, but the potential significance of any impact may be high. However, any potential negative impact on the areas palaeontological heritage can be mitigated to an absolute minimum should adequate mitigation procedures be put into place (see Sections 9.1 and 12 below). In the event of these suggested mitigation protocols being properly implemented the potential benefit of the project will outweigh the threat of a negative impact.

A second significant potential benefit 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.

8.7 Status

Given the combination of factors outline and the proposed mitigation procedures discussed above, it is evident that little negative effect on the palaeontological heritage of the area is anticipated as a result of the proposed project. As the proposed project would supply renewable electricity to the stressed South African national power grid the project is determined as having a **positive status** herein.

9 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the 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.

9.1 Mitigation

A thorough site investigation by a palaeontologist along the entire extent of the power line alternative that is eventually selected should be conducted prior to the commencement of construction as part of a full EIA study. This would allow a meaningful evaluation of the presence of potentially fossil-bearing strata within the project 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 scientifically or culturally significant fossil materials exist within the project area any negative impact upon them could be mitigated by their 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.

It is also recommended that a close examination of all excavations associated with the construction of the project be made by a palaeontologist while they are occurring. Should any fossil materials be identified, the excavations should be halted and SAHRA informed of the discovery (as per legislative requirements outlined in Section 3.3 above). A significant potential benefit of the examination of the excavations associated with the construction of the project is that currently unobservable fossils may be uncovered. As long as the construction process is closely monitored it is possible that potentially significant fossil material may be made available for scientific study.

9.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials is **irreversible**.

9.3 Degree of irreversible loss

Once a fossil is damaged, destroyed or is moved from its original location in an undocumented manner the **damage is irreversible**. However, by their nature fossils are usually rare and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. Any fossil material may be of the greatest scientific importance; this is particularly true of vertebrate fossils in which many taxa are

known from only one fossil. Thus, the potential always exists during construction and excavation of potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete 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. However, the judgement on the significance of the fossil must be made by a suitable experienced palaeontologist.

10 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.

11 ENVIRONMENTAL IMPACT STATEMENT

A desktop paleontological study has been conducted on the sites of seven (7) alternative locations for power 66 to 132 kV lines, one of which could connect an environmentally approved Springfontein wind power generation facility to the South African power grid. This desktop study will form part of a Heritage Impact Assessment Report that is a component of an Environmental Impact Assessment to identify asses all potential environmental impacts associated with the proposed project.

The project infrastructure that will be required for the successful completion of the project is one 66 to 132 kV power line with a 32 m wide servitude. The potential negative impacts upon the palaeontological heritage of the area will be caused by any excavations that are required for the installation of the power line pylons as well as of any access road that is produced within the area of the servitude.

Three geological units underlie various portions of the seven alternative power line routes; these being:

- Sediments of the Adelaide Subgroup,
- Igneous intrusive rocks of the Karoo Dolerite Suite,
- Cenozoic alluvium.

Of these geological units the Adelaide Subgroup and Cenozoic alluvium are known to be fossiliferous where they occur elsewhere within the Karoo region. Indeed, the rocks of the Adelaide Subgroup which underlie the project area potentially contain extremely

scientifically and culturally important fossils of the *Cistecephalus* Assemblage Zone. This importance is based on the fact that elsewhere the biostratigraphic zone contains a rich and diverse vertebrate fauna that in part documents the evolutionary transition from reptiles to mammals. The Karoo Basin sedimentary infill forms one of the most complete and important lithological sequences anywhere in the world for documenting this evolutionary succession.

All proposed infrastructural elements that comprise the proposed project are restricted to the project area and the extent of any negative impacts is restricted to the location of the infrastructure. Accordingly, the extent of any negative impacts is assessed as being local. Most infrastructural elements will directly affect the surface of the site to a very shallow depth, with the deepest being presumed to be less than 2 m in depth (i.e., the foundations for the power pylons). The probability of any negative impacts is assessed as improbable, due to the generally scarce and erratic occurrence of fossils within the geological record. However, do to the extremely high scientific and cultural significance of any fossil materials that may be present beneath the proposed constructions the potential negative impacts of the project are assessed as being high. The potential threats posed to any fossil materials are their destruction, damage or accidental and undocumented removal from their original site (i.e., loss of their exact stratigraphic and geographic location). These potential negative impacts would be permanent and irreversible.

The possible impacts resulting from each of the seven alternative 66 to 132 kV power line routes has been assessed against a set of standardised criteria (Appendix A) and found to be identical. The relative weightings of any impacts upon the palaeontological heritage of for all of the seven alternative routes are presented in Table 1.

Nature: Destruction, damage and loss of provenance of fossil materials		
	Without Mitigation	**With Mitigation**
Extent:	Low (3)	Low (3)
Duration:	Permanent (5)	Permanent (5)
Magnitude:	High (10)	Minor (2)
Probability:	Improbable (2)	Improbable (1)
Significance:	**Medium (36)**	**Low (9)**
Status:	Positive	Positive
Reversibility:	Impossible	Impossible
Irreplaceable loss of resources:	Low	Low
Can impacts be mitigated:	Yes	
Mitigation: All excavations must be inspected for fossil content. Should fossils be located the relevant exaction must be halted and SAHRA informed of the find. SAHRA may instruct that a palaeontologist should evaluate the fossil material and suggest appropriate protocols to either excavate or protect the fossil material.		
Cumulative impacts: None		
Residual impacts: Permanent loss of fossil heritage		

Table 1: Summary palaeontological heritage impact assessment table for the proposed power line route.

The social benefits of the project have been classified, herein, as beneficial because the project aims to provide a renewable source of energy to the South Africa power grid and the power generation capacity of South Africa is presently under significant pressure. A series of damage mitigation procedures are outlined below (Section 12). If these mitigation protocols are adequately implemented any negative impacts on the palaeontological heritage of South Africa will be minimised. Indeed, if new fossil localities are identified during the conduct of these procedures there will be a positive impact on the state of scientific knowledge of the palaeontology of the geological units involved. As such, **this desktop study has not identified any palaeontological reason to prejudice the progression of the one power line, subject to adequate mitigation programs being put in place**.

12 RECOMMENDATIONS

The following recommendations are made for the future conduct of the project in order to reduce the potential for any negative impact on the area to an absolute minimum:

- A thorough site investigation (i.e., a full palaeontological heritage impact assessment study) be made of the entire route of the power line route that is eventually selected

be made by a palaeontologist as part of the EIA process prior to commencement of any construction.

- Regular inspections should be made by a palaeontologist of all excavations and construction during the development of the project to identify any fossil materials that may be uncovered.
- Should any fossil material be located during either the construction of the proposed substation and its infrastructure elements operations excavations should be halted and SAHRA informed of the discovery.
- Should any fossil materials be identified a palaeontologist should be contacted to evaluate the material and advise on its scientific importance and, if necessary, excavation or preservation.

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22nd February 2014

APPENDIX A

Standard Conventions for Assessing Impacts

Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified as a result of this study have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

Where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).