Palaeontological survey and report for the proposed upgrade of Section 2 of the R61 road located between Graaf Reinet and Cradock

Prepared for: SRK Consulting

P O Box 21842

Port Elizabeth

6000

Compiled by: Robert Gess

Rob Gess Consulting

Research Associate of the Albany Museum

c/o Box 40

Bathurst

6166

robg@imaginet.co.za

February 2012

Contents:

Background

The proposed project entails the upgrade and widening of section 2 of the R61. This section is 13 km long and is located between Graaff-Reinet and Cradock.

Rob Gess Consulting was subcontracted to carry out a palaeontological survey and make recommendations regarding palaeontological heritage. Survey work was performed in February 2012.

Geology and Palaeontology

Section 2 of the R61 crosses strata of the Elandsberg member of the Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup)

The strata of the **Karoo Supergroup** were deposited within the Karoo sedimentary Basin, which resulted from shortening and thickening of the southern margin of Africa, with coeval folding and uplift of the Cape Supergroup strata along its southern margin. The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods. During this interval the basin evolved from an inland sea flooded by a melting ice cap, to a giant lake (the Ecca Lake) fed by seasonal meandering (and at times braided) rivers. This lake steadily shrank as it filled with sediment and the basin's rate of subsidence stabilised. The land became increasingly arid and was covered with wind blown sand towards the end of its cycle. Finally the subcontinent was inundated with basaltic lava that issued from widespread linear cracks within the crust, to form the capping basalts of the Drakensberg Group.

As the Ecca Lake silted up a subaerial (exposed) shoreline began to develop, initially in the south east of the basin. The lake steadily shrank towards the centre of the basin, leaving behind flat silty plains across which long rivers meandered from the Cape Mountains towards the much reduced lake. Sands were deposited along the river channels whereas periodic flooding deposited muds on the broad flood planes. These in time came to form the interbedded sandstones and mudstones of the Koonap Formation, Middleton Formation and **Balfour Formation** (**Adelaide Subgroup**, **Beaufort Group, Karoo Supergroup)**.

The flood planes of the **Beaufort Group (Karoo Supergroup)** provide an internationally important record of life during the early diversification of land vertebrates. Giant amphibians coexisted with diapsid reptiles (the ancestors of dinosaurs, birds and most modern reptiles), anapsids (which probably include the ancestors of tortoises) and synapsids, the dominant group of the time which included the diverse therapsids (including the ancestors of mammals). Rocks of the Beaufort Group provide the worlds most complete record of the important transition from early synapsids to mammals.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content.

This part of the **Balfour Formation** (**Adelaide Subgroup, Beaufort Group, Karoo Supergroup**) corresponds to the *Dicynodon* Assemblage Zone. Characterised by the co-occurence of two therapsids, *Dicynodon* and *Theriognathus* this zone demonstrates the Beaufort Groups greatest diversity of vertebrate taxa, including numerous genera and species of dicynodont, biarmosuchian, gorgonopsian and therocephalian and cynodont therapsid Synapsida, together with diverse captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Pisces. Trace fossils of invertebrates and vertebrates as well as *Glossopteris* flora plants are also described. The upper Balfour Formation provides important evidence regarding the fauna and flora, immediately preceding the Permotriassic extinction event which decimated the vertebrate fauna and extinguished the diverse glossopterid plants.

During the formation of the volcanic **Drakensberg Group (Stormsberg Group, Karoo Supergroup)**, in the Jurassic Period, crack like fissures in the earths crust became filled with molten lava that later cooled to form dolerite dykes. Other magma was injected under pressure between horizontal sedimentary strata and cooled to form extensive horizontal sills of dolerite. Dolerite, being an intrusive igneous rock, contains no fossils.

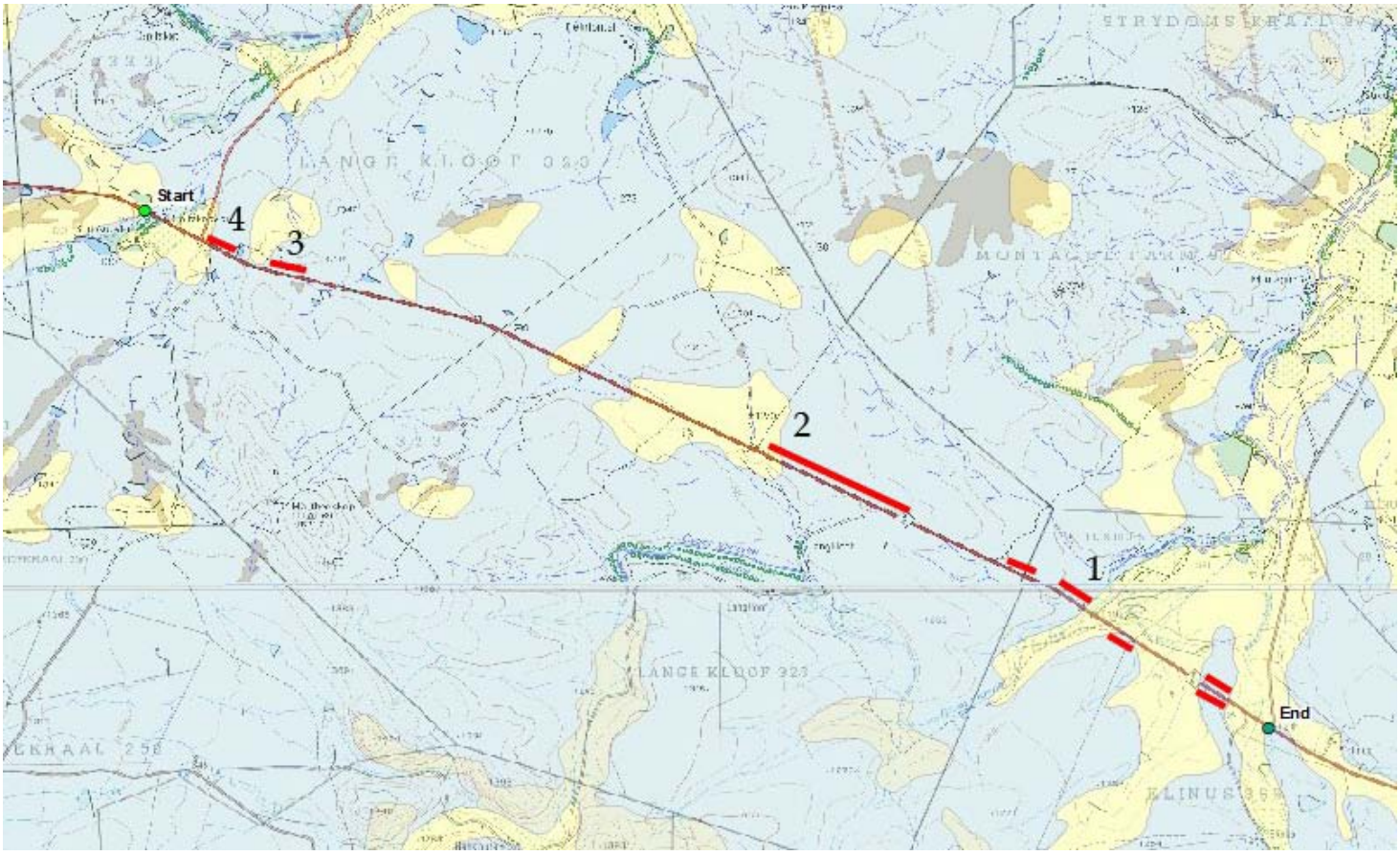

Figure 1: Map of the study area, combining Geological Survey data with road layout.
Blue = Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup). Grey = Jurassic dolerite, Yellow = Quaternary cover. Red lines indicate the position of road cuttings. Numerals = points of interest. Road section = 13 km long

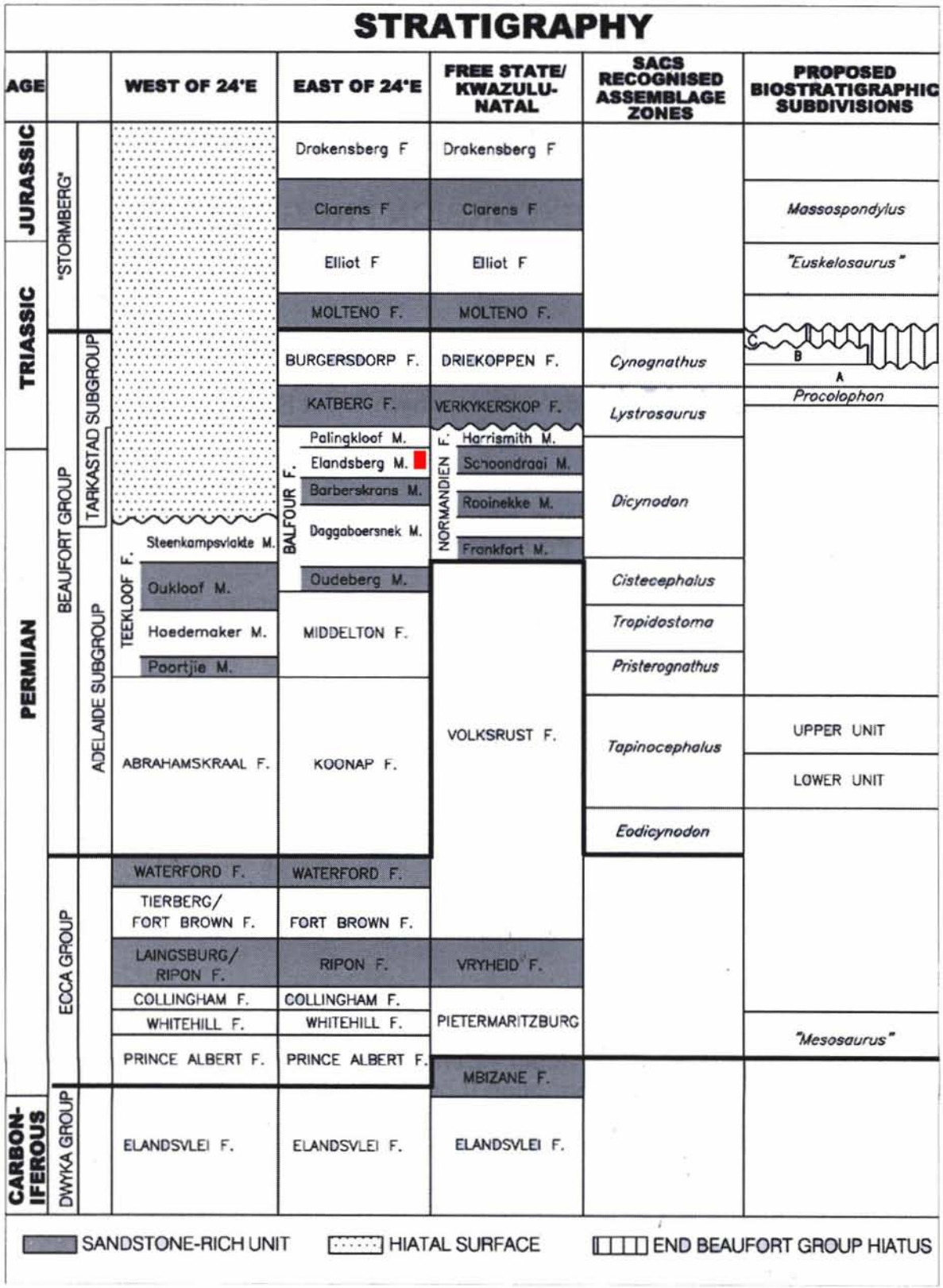

Figure 2. Stratigraphic column and corresponding biostratigraphy of the Karoo Supergroup (modified after Rubidge). Red line indicates probably range of strata affected by the development.

Site Visit

The borrowpits, quarry and section of road were surveyed during February 2012.

The quarry and borrow pits are all excavated into dolerite sills adjacent to the study area. Small amounts of altered sandstone exposed did not appear to have palaeontological potential.

Figure:3 Dolerite exposed in borrow pit E

A number of roadcuttings exposing interbedded greenish mudstones and sandstones of the Balfour Formation (Beaufort Group, Karoo Supergroup) were identified (fig. 1. red lines, Fig.4). These were all exhaustively examined on foot. A number of fossils were located.

At point 1(see Figure 1) a number of plant stems, including sphenopsid stems, and other plant fragments were noted (see Figs 6,7). Shallow water ripple surfaces (Fig. 5) were common here as well as at other outcrops.

Figure 4: Interbedded greenish mudstones and sandstone at point 1 (Fig.1)

Figure 5: Shallow water ripples exposed at point 1 (Fig. 1)

Figure 6: Plant fragment at point 1.

Figure 7: Plant fragments at point 1, lag deposit (at top), Sphenophyte stem (below)

Vertical invertebrate burrow casts (Fig. 8) were noted at site 2 (see Figs 1)

Figure 8: Small vertical invertebrate burrows at site 2 (see Fig. 1)

At Point 3 (Fig. 1) a number of probable small vertebrate burrows were discovered (Figure 9, top). These are subvertical with an elbow about half way down. A faint impression of a glossopteris leaf was noted at the same site (Figure 9, bottom).

Figure 9: Locality containing burrow casts (point 3, Fig. 1). Vertebrate burrow at 31 58 02 S, 25 03 18 E (*top left*), detail of burrow locality with burrow above geological hammer (*top right*), faint impression of a *Glossopteris* leaf at point 3 (*bottom*).

At point 4 (31 57 52 S, 25 02 24 E) dicynodont bones were found preserved as nodules within siltstone.

Figure 10: Point 4: field assistant indicating position of fossiliferous nodules (*top*), nodules containing dicynodont bones (*bottom left*) , detail of nodule showing a dicynodont tusk within the maxilla.

Conclusions and Recommendations

It may safely be concluded that no important palaeontological material will be disturbed during activities at the borrowpits and quarry.

Although plant fossils were found at point 2 their preservation was unremarkable and they consisted largely of stem fragments.

Significant fossil sites occur at points 3 and 4 where vertebrate burrows and vertebrate bones are preserved. As these sites will be cut back during widening of the road it is recommended that cutting back of these two road cuttings is monitored by a palaeontologist who will rescue currently exposed material and any new material that becomes apparent during cutting back of these horizons. Close collaboration with the site engineer and machine operator will be required

It is recommended that **all other road cuttings should be inspected by a palaeontologist at the completion of works, prior to any form of rehabilitation**.

References

Anderson, J.M. and Anderson, H.M. (1985). *Palaeoflora of Southern Africa: Prodromus of South African Megaflora*s; Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. p.423

Council for Geosciences (Geological Survey) 1:250 000 Geological Maps, map *3124 Middleberg*

McCarthy, T. and Rubidge, B. (2005). *The Story of Earth and Life*. Struik Publishers, Cape Town

Rubidge B.S. (Ed) (1995). Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy (SACS), *Biostratigraphic Series No. 1*. Council for Geosciences, Dept. of Mineral and Energy Affairs S.A. p.46.

Smith, R., Rubidge, B. and van der Walt, M.(2012). Therapsid Biodiversity Patterns and Palaeoenvironments of the Karoo basin, south Africa in ed Chinsamy Turan, A. *Forerunners of Mammals*. IndianaUuniversity Press