PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE PROPOSED UPGRADING AND ESTABLISHMENT OF MATERIAL SOURCES FOR THE UPGRADING OF NATIONAL ROUTE R335 BETWEEN MOTHERWELL (KM 5.600) AND ADDO (KM 37.600), WITHIN THE NELSON MANDELA BAY MUNICIPALITY AND SUNDAYS RIVER VALLEY LOCAL MUNICIPALITY, EASTERN CAPE PROVINCE

Prepared for:

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EXECUTIVE SUMMARY

The Department of Roads and Public Works (DRPW) appointed GIBB (Pty) Ltd as consulting engineers for the 'Improvement of National Route R335 between Motherwell (km 5.600) and Addo (km 37.600)' within the Nelson Mandela Bay Municipality (NMBM) and Sundays River Valley Local Municipality (SRVLM). According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the upgrading of Main Road between Motherwell and Addo on the palaeontological resources.

The development area is completely underlain by sediments of the Sundays River, Kirkwood and Enon Formations of the Uitenhage Group, the Witteberg Group of the Cape Supergroup as well as the Algoa Group. During a field survey poorly- to fairly well-preserved loose as well *in situ* fossil assemblages were recorded within the proposed development.

1. *The EAP as well as the ECO for this project must be informed that* sediments of the Sundays River and Kirkwood Formations of the Uitenhage Group, the Witteberg Group of the Cape Supergroup as well as the Algoa Group has a high to very high Palaeontological Sensitivity.
2. Mitigation by a palaeontologist is thus recommended. Mitigation will entail the collection and recording of fossils as well as obtaining important data of the surrounding sedimentary matrix within the proposed development footprint. Excavation of this fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. All fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA
3. These recommendations must be incorporated into the Environmental Management Plan for the Motherwell road upgrade project

CONTENTS

1 INTRODUCTION

Terratest (Pty) Ltd has been appointed as the independent Environmental Assessment Practitioners (EAP) on behalf of the Department of Public Works to undertake the Environmental Impact Assessment process as well as the application process for an Environmental Authorisation of material sources, as required in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

The project entails the re-alignment and widening of the road, drainage infrastructure upgrades, widening and/or replacement of bridges and culverts and all other associated road furniture (Fig. 1-7). This would require obtaining material (including gravel and rock) from local areas, for use in construction as bedding, backfill as well as layer works material.

MATERIAL RESOURCES

To supply the material essential for the proposed road upgrade, it is suggested to make use of seven material sources:

MATERIAL SOURCE NAME	STATUS	MATERIAL TYPE
Borrow Pit 2	New	Sandstone, shale and mudstone
Borrow Pit 3	New	Calcrete and silty sands
PPC 1	New	Calcareous sandstone and calcrete
PPC 2	New	Calcareous sandstone and calcrete
PPC 3	New	Calcareous sandstone and calcrete
PPC 4	New	Calcareous sandstone and calcrete
Waggie Quarry	Existing	To be confirmed

A multistage crusher plant will most probably be established at the Waggie Quarry and the PPC site while a two-stage crusher may be required at Borrow Pit 2 and 3.

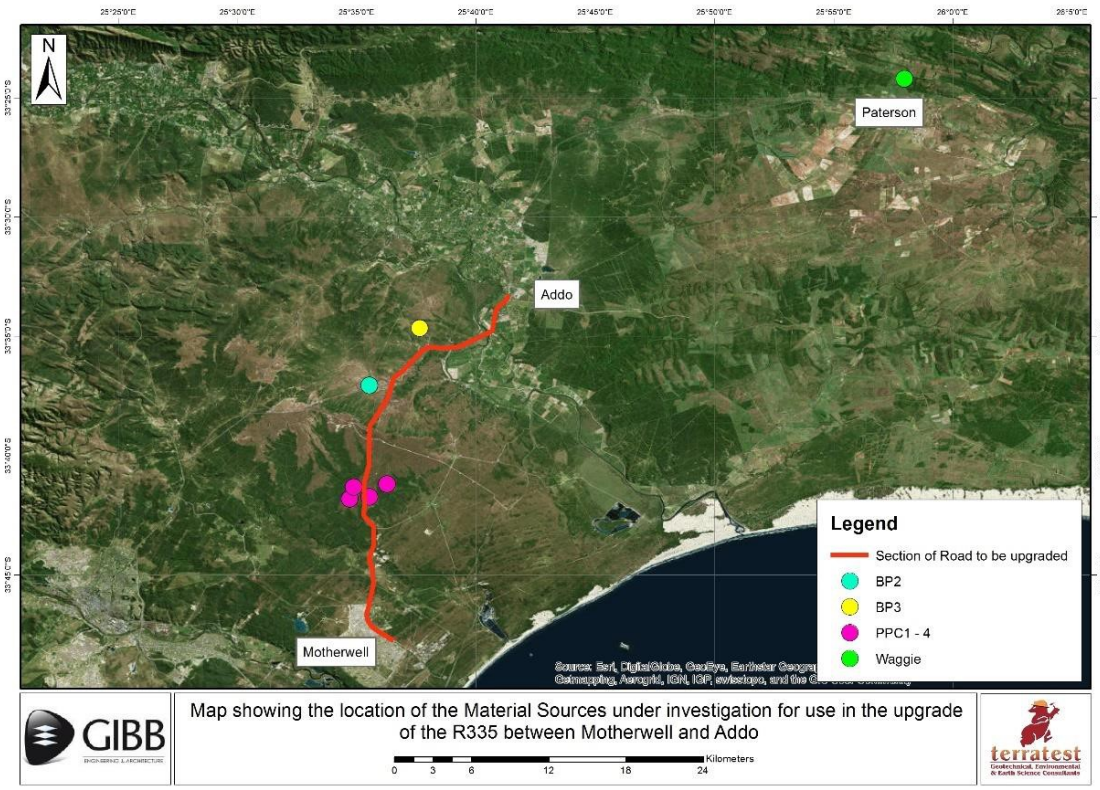


Figure 1: Localities of the material sources for the route MR 450 Motherwell upgrade project. Map provided by Gibb (Pty) Ltd and Terratest (Pty) Ltd.

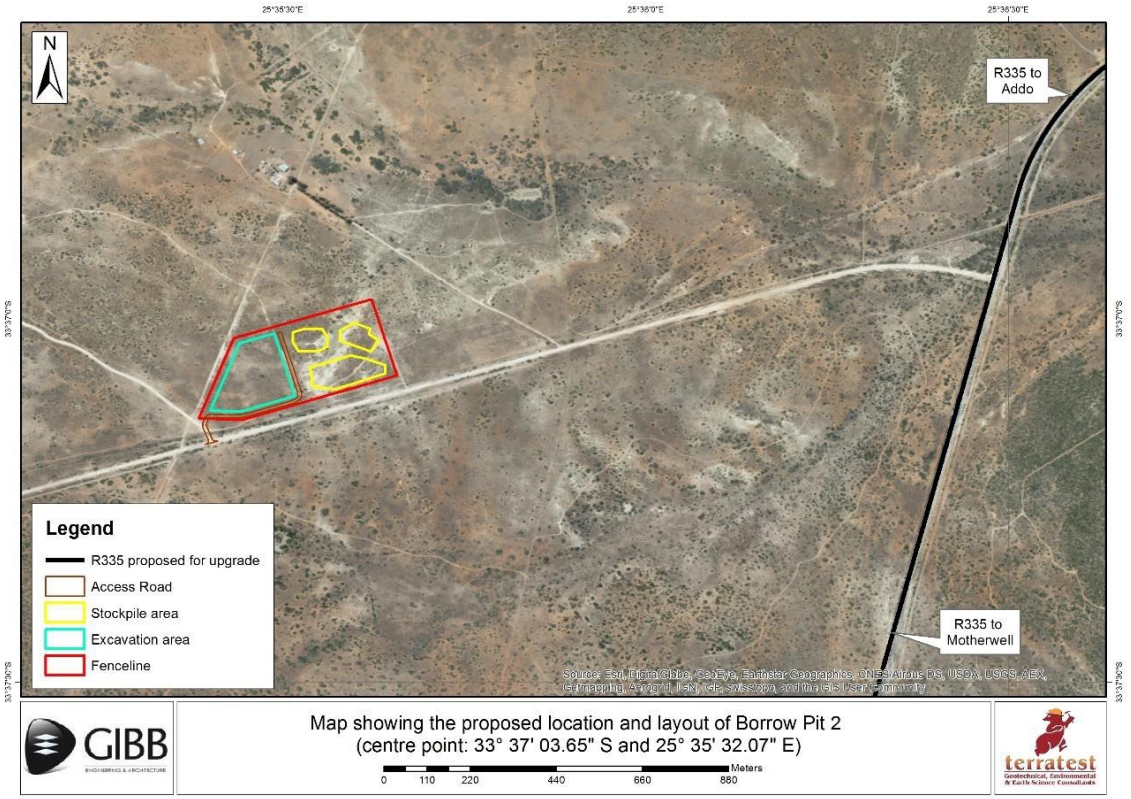


Figure 2: Proposed location and layout of Burrow Pit 2. Map provided by Gibb (Pty) Ltd and Terratest (Pty) Ltd.

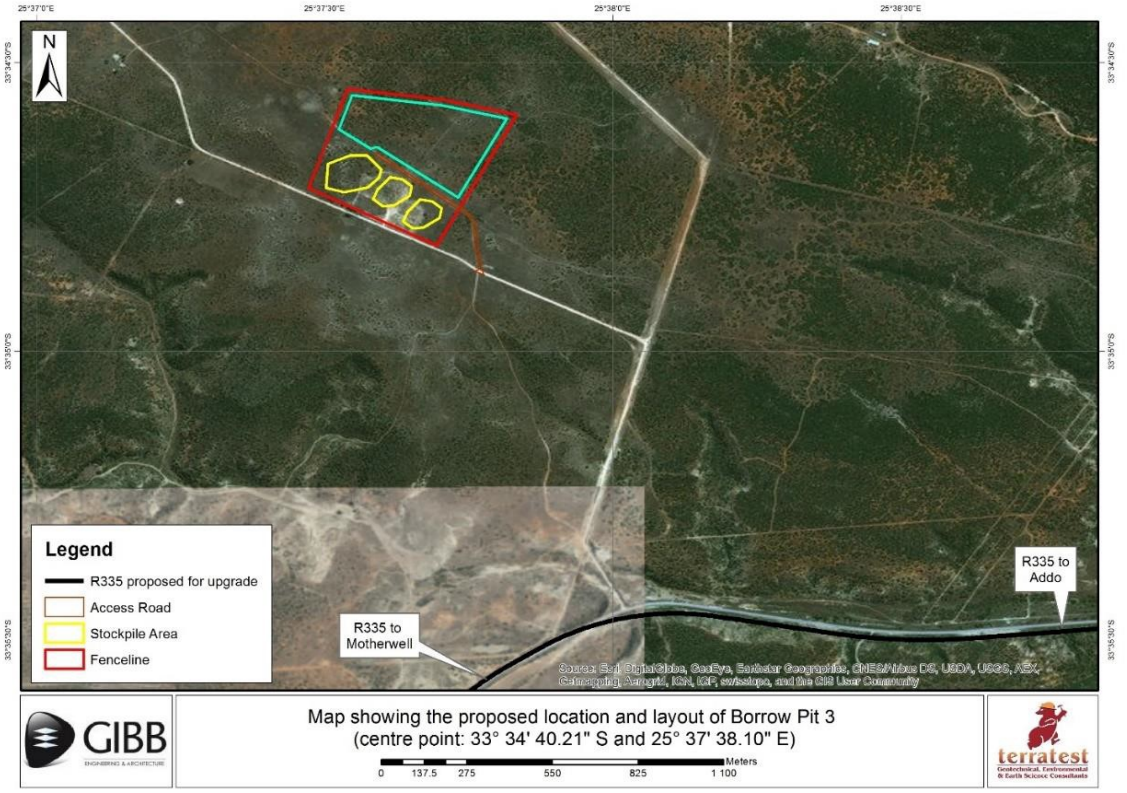


Figure 3: Proposed location and layout of Burrow Pit 3. Map provided by Gibb (Pty) Ltd and Terratest (Pty) Ltd.

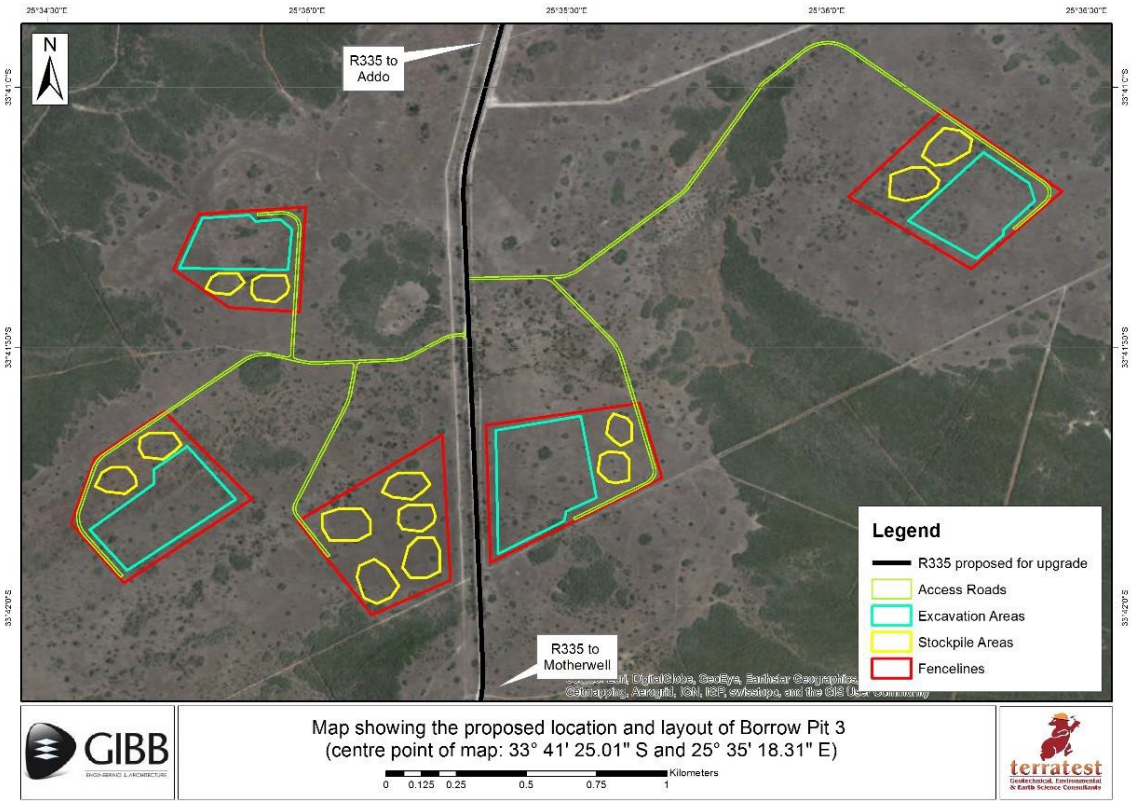


Figure 4: Proposed location and layout of the PPC Burrow Pits. Map provided by Gibb (Pty) Ltd and Terratest (Pty) Ltd.

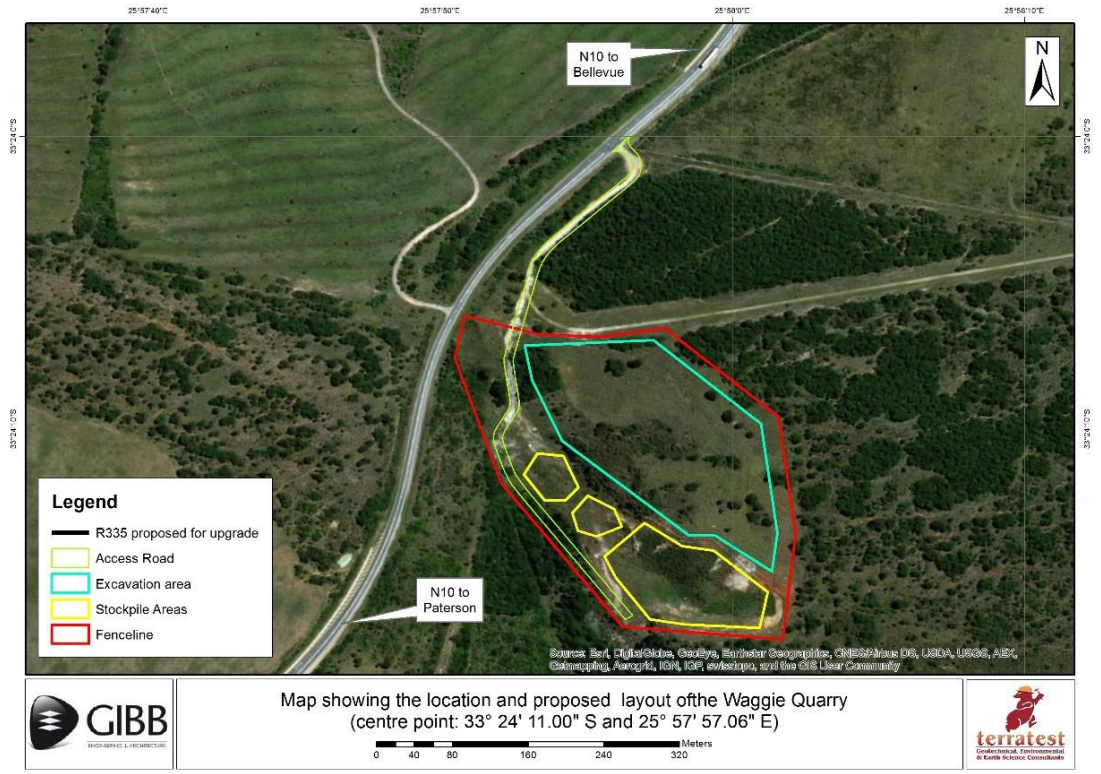


Figure 5: Proposed location and layout of Waggie Quarry. Map provided by Gibb (Pty) Ltd and Terratest (Pty) Ltd.

A DESCRIPTION OF THE PROPOSED UPGRADING FOR THE MR450 / R335:

A double traffic lane will begin at the WM Maku intersection (km 5.600) and continue up to the intersection with the R334 (km 9.300) where it switches to a single traffic lane cross section. This single carriageway then carries on from km 9.430 up to km 37.600 which is the end of construction just outside Addo village.

An offset alignment of 7 m will be used for the horizontal alignment from the intersection with the R334 (9.580 km) up to the Sunday's river bridge (km 34.700). From where the alignment returns to the existing centreline and the road is widened centrally to avoid affecting trees within the citrus farms up to 37.600 km before entering Addo

Batter slopes shall be constructed to a constant slope of 1 vertical and 1.5 horizontal for all cut and fill conditions. Bannisters in combination with a concrete kerb and channel will mostly be provided at all fills higher than 3.0 m and at retaining structures. The road profile width will remain at 13.4 m where guardrails are present.

Existing culverts:

Culvert A crosses DR01958 at km 0.120. DR01958 intersects R335 at km 26.815 – There is currently no culvert and the road overtops and becomes impassable.

Culvert B crosses R335at km 27.120 – There is currently one 600 mm pipe and the road overtops frequently.

Culvert C crosses R335 at km 28.825 - There is currently two 600 mm pipe and the road overtops often.

Culvert D crosses R335 at km 29.305 - There is currently two 600 mm pipe and the road overtops regularly.

Culvert E crosses R335 at km 30.770 - There is currently two 2.2 m Arch Culvert and the road overtops frequently.

Culvert F crosses R335 at km 32.327 - There is currently two 2.2 m Arch Culvert and the road overtops frequently.

Culvert G crosses MN50267 at km 0.080. MN50267 intersects R355 at km 30.730 - There is currently no Culvert and the road overtops often.

New / Upgraded:

Culvert A = 2:	2.4 high x 2.4 wide (new)
Culvert B = 3:	3.2 wide x 3.4 wide (upgraded)
Culvert C = 3:	2 wide x 3.4 wide (upgraded)
Culvert D = 3:	3.2 wide x 3.4 wide (upgraded)
Culvert E = 3:	3.2 wide x 3.4 wide (upgraded)
Culvert F = 3:	3.2 wide x 3.4 wide (upgraded)
Culvert G = 2:	2 wide x 1.8 wide (new)

COEGA RIVER BRIDGE:

The Coega River Bridge will be demolished and reconstructed on a new horizontal and vertical alignment close to the existing bridge and will have a road width of 13.4m. F-shaped concrete parapets will be placed along the outer edges of the bridge deck and increases the bridge width to 14.35m and the length to 25m. Guardrails will be placed on the approach embankments. The upstream and downstream sides of the approach embankments will be protected by gabion mattresses and boxes.

SUNDAYS RIVER BRIDGE:

The Sunday's river bridge will be reconstructed and widened (km 34.80). The current bridge is a three-span, reinforced concrete fixed arch structure with spandrel walls. The spans are each 31.39m in length and the total bridge length is 118.6m. As it will be necessary to widen the deck the existing balustrades and sidewalks shall be broken down, and a duplicate bridge will be constructed alongside the existing structure to accommodate the wider road profile. The new deck will accommodate a road width of 13.4 m. The new surface area of the Sundays River Bridge will be 13.4m x 118.6m = 1 589.24 m^2.

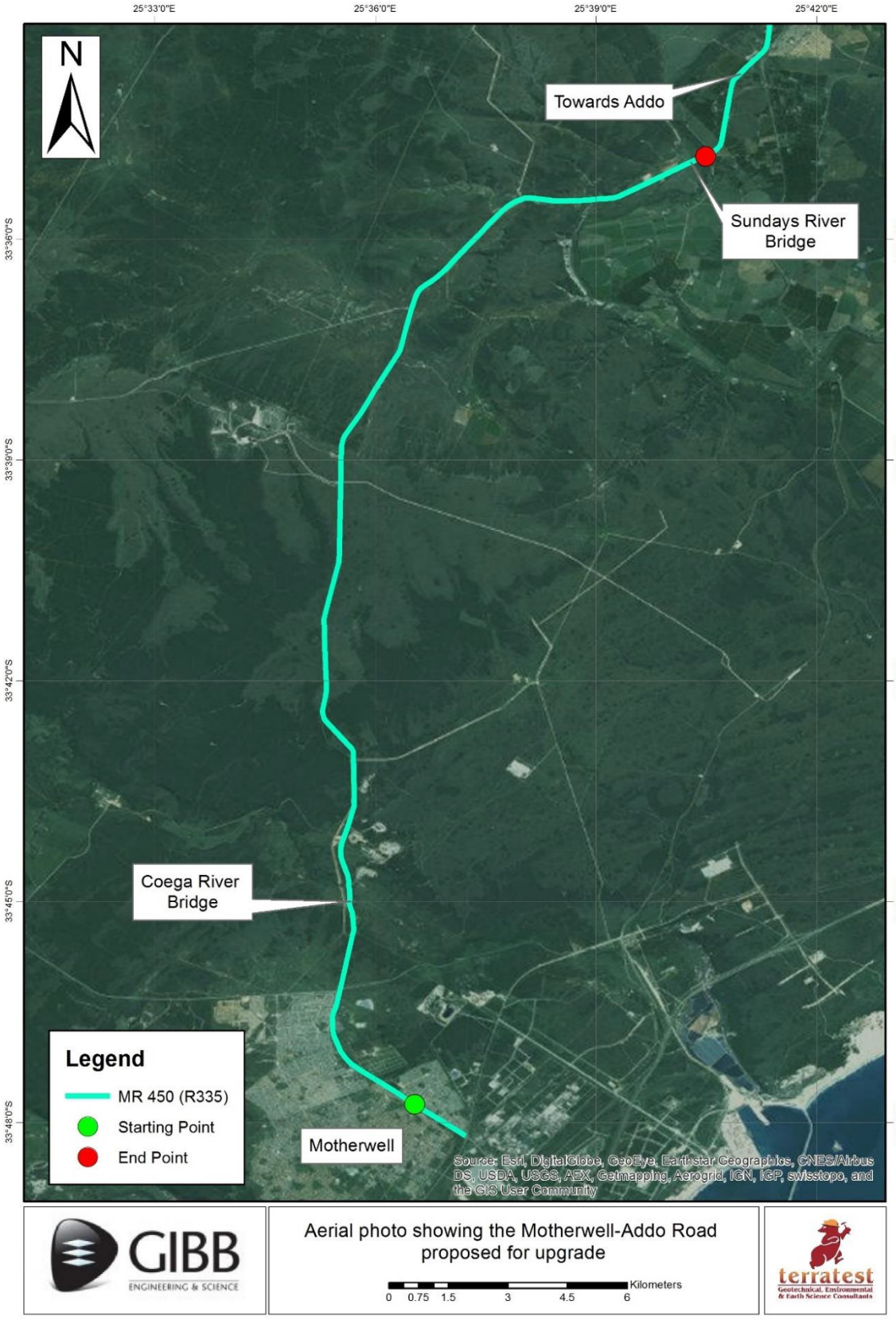


Figure 6: Aerial photo indicating the section of route MR 450 proposed for upgrade. (Map provided by Terratest).

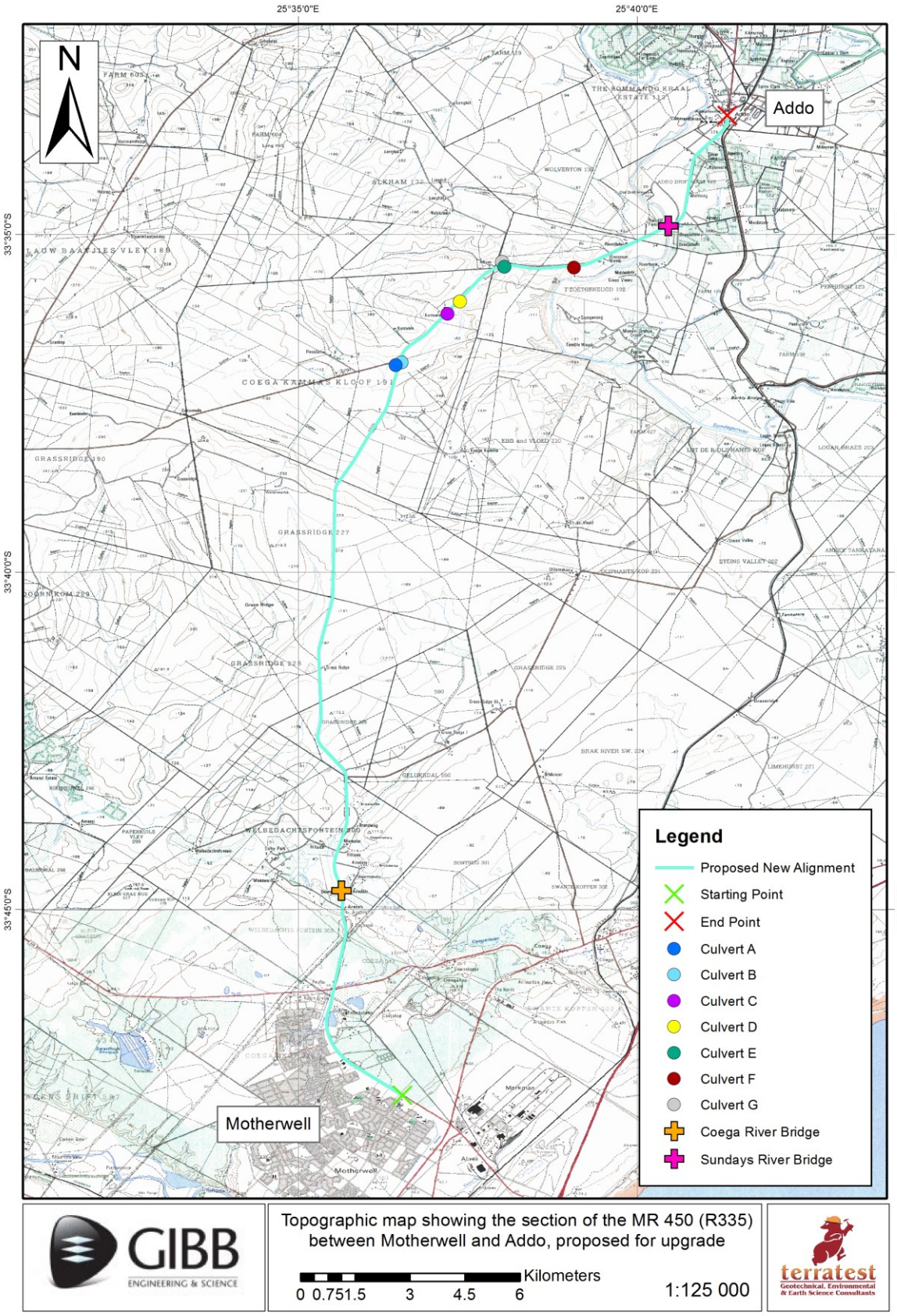


Figure 7. Topographic map indicating the location of the section of route MR 450 proposed for upgrade. (Map provided by Terratest).

2 LEGISLATION

2.1 NATIONAL HERITAGE RESOURCES ACT (25 OF 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, moved, broken or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Desktop Assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
- the construction of a bridge or similar structure exceeding 50 m in length;
- any development or other activity which will change the character of a site—
- (exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m^2 in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

3 OBJECTIVE

The objective of a Palaeontological Desktop Assessment is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to identify

the palaeontological importance of the exposed and subsurface rock formations in the development footprint 2) to evaluate the palaeontological importance of the formations 3) to determine the impact of the development on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontological desktop study is compiled, the potentially fossiliferous rocks (i.e. groups, formations, etc.) present within the study area are established from 1:250 000 geological maps. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within each rock section is obtained from previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations specifically in areas close to the development area). The palaeontological importance of each rock unit of the development area is then calculated. The possible impact of the proposed development footprint on local fossil heritage is established on the following criteria: 1) the palaeontological importance of the rocks and 2) the type and scale of the development footprint and 3) quantity of bedrock excavated.

In the event that rocks of moderate to high palaeontological sensitivity are present within the study area, a field-based assessment is required. Based on both the desktop data and field examination of the rock exposures, the impact significance of the planned development is measured with recommendations for any further studies or mitigation. In general, destructive impacts on palaeontological heritage only occur during construction. The excavations will transform the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation comprises the sampling, collection and recording of fossils and may precede construction or, more ideally, occur during construction when potentially fossiliferous bedrock is exposed. Preceding the excavation of any fossil heritage a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

4 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

4.1 GEOLOGY

The proposed development area is located in the Algoa Basin and is underlain by sediments of the Cretaceous aged (approximately 140 million years old) Kirkwood Sundays River and Enon Formations

of the Uitenhage Group, the Witteberg Group of the Cape Supergroup as well as the Algoa Group (Fig. 8-11). The Kirkwood Formation consists of readily-weathered variegated (reddish-brown and green) silty mudrocks and subordinate sandstones of fluvial origin while the Sundays River Formation consists largely of grey coloured mudstone, siltstone and subordinate sandstone. The geology of the Algoa Group consists of clastic limestone and conglomerates. The Mid-Devonian to Early Carboniferous Witteberg Group consists mainly of sandstone of deltaic origin, overlain by marine shales.

4.2 PALAEONTOLOGY

The geological formations underlying the development footprint if from the Uitenhage and Algoa Group. Fossils present in these groups include the remains of rich marine and estuarine invertebrate fauna (bryozoans, brachiopods, corals, crustaceans, echinoids, molluscs (terrestrial and marine), microfossils, sharks' teeth as well as trace fossils.

The **Kirkwood Formation** from the Early Cretaceous is known for its terrestrial biotas. Fossils of this formation include vascular plants (charcoal, lignite beds, and petrified logs), while tetrapod vertebrates include dinosaurs. Freshwater invertebrates are also present in this formation. Various dinosaur remains have been described from the Kirkwood Formation and include leg bones, teeth and vertebrae. The best preserved Kirkwood dinosaur is Nquebasaurus which was described by De Klerk *et al* (2000). But, most of the dinosaur fossils found in the Kirkwood Formation is fragmentary. Gymnosperms dominated the woody vegetation and include conifers, extinct cycad-like bennettitaleans and true cycads. Freshwater algae include charophytes, bryophytes and pteridophytes (ferns) while pollens and spores are commonly found. Amber (without imbedded insects) and charcoal are common. Other vertebrate fossil groups from the Kirkwood Formation include crocodiles, frogs, turtles, and lizards, mammals and freshwater fish. Non-marine invertebrate fossils include freshwater or estuarine molluscs, insects and several groups of small crustaceans have been described from this formation. Trace fossils include borings into petrified tree trunks.

The **Sundays River Formation** is known for its shallow–marine deposits. These deposits most probably may include estuarine, lagoonal and shallow shelf settings. Invertebrate shells, plants, vertebrate fragments and microfossils are commonly recovered. Most fossils remains from this formation are fragmentary but almost complete skeletons of the marine plesiosaur were uncovered. Ammonites are commonly found in the Sundays River.

The Mid-Devonian to Early Carboniferous **Witteberg Group** is known for its trace fossils, occasional shelly invertebrates which include brachiopods and bivalves as well as fish. Vascular plant (petrified wood) are also found.

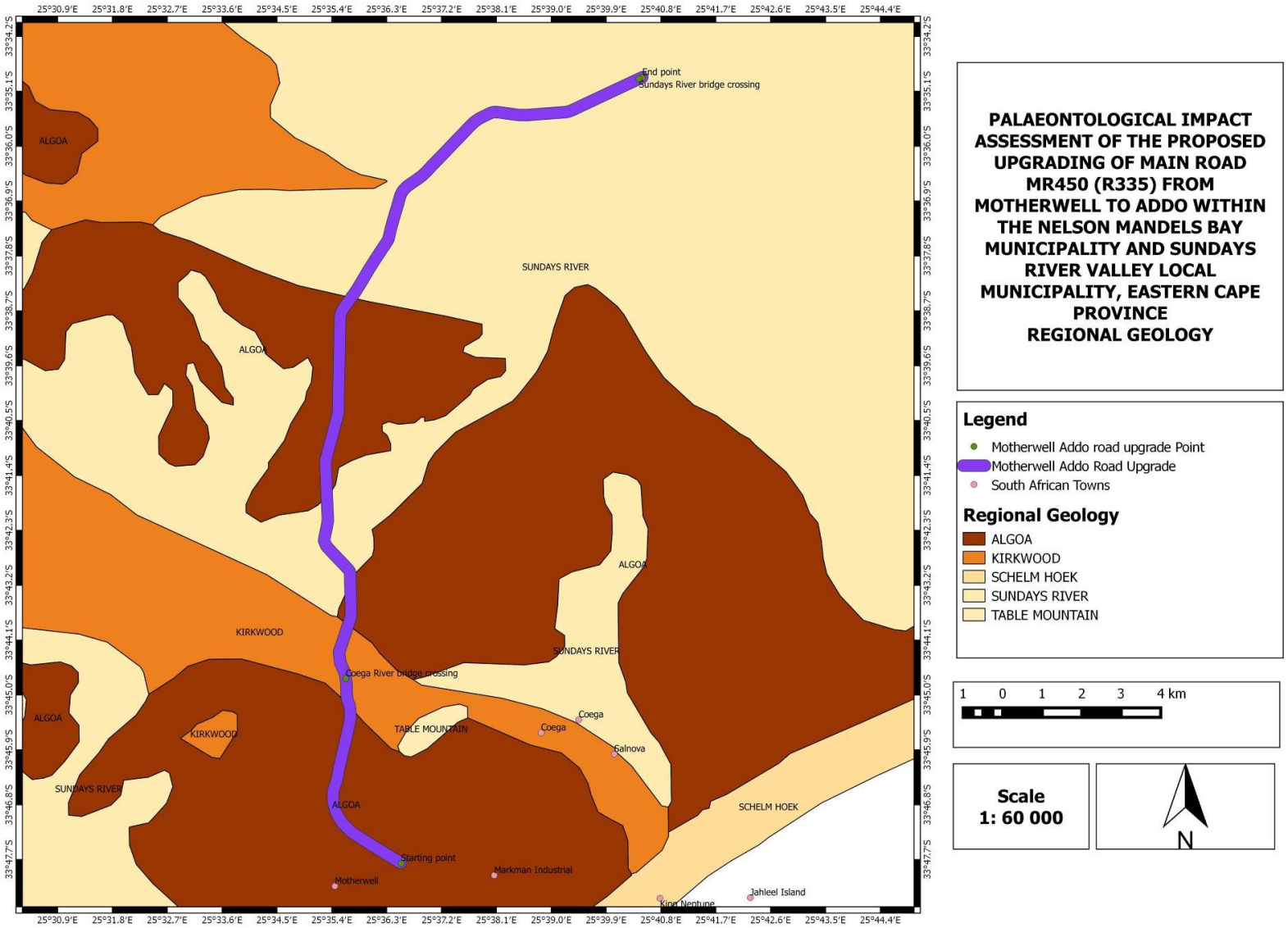


Figure 8. The surface geology of the proposed Motherwell-Addo upgrade within the Nelson Mandela Bay Municipality and Sundays River Valley Local Municipality, Eastern Cape Province. The development area is completely underlain by the Uitenhage Group (Kirkwood and Sundays River Formations) and Algoa Group. Map drawn QGIS Desktop 2.18.14.

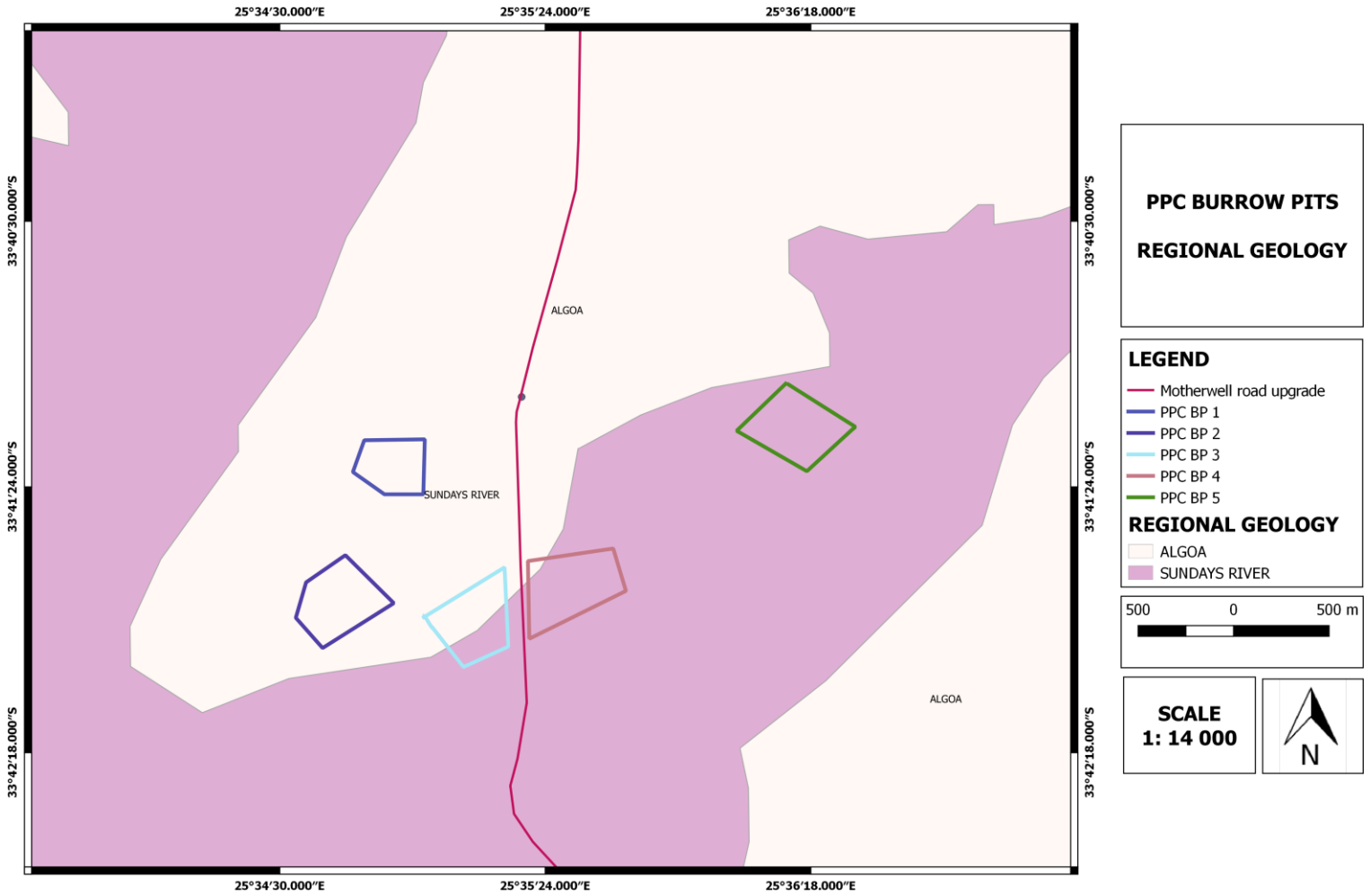


Figure 9. The surface geology of the proposed PPC BP within the Nelson Mandela Bay Municipality and Sundays River Valley Local Municipality, Eastern Cape Province. The development area is completely underlain by the Sundays River Formations and Algoa Group. Map drawn QGIS Desktop 2.18.18.

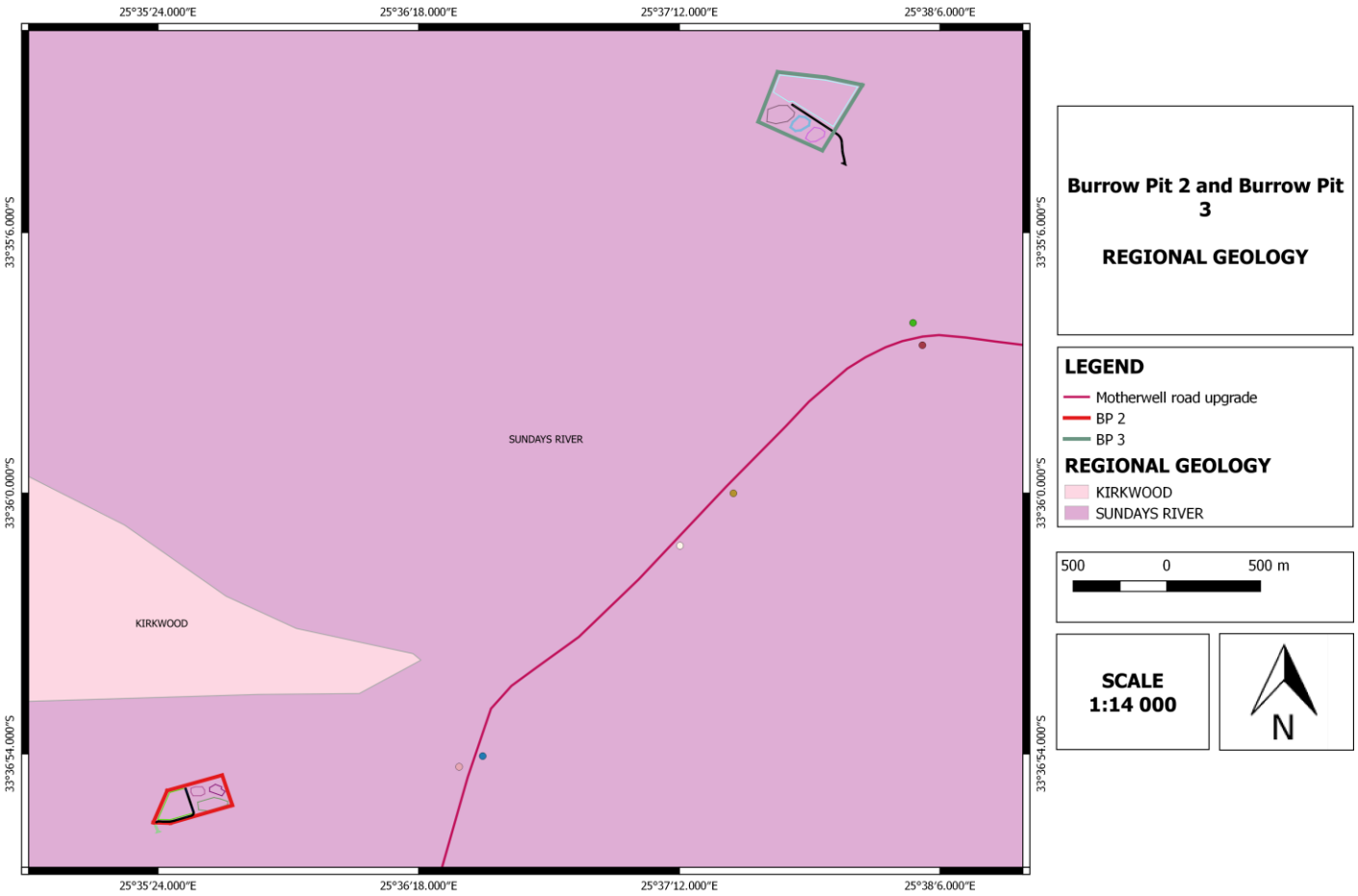


Figure 10. The surface geology of the proposed Burrow Pit 2 and 3 within the Nelson Mandela Bay Municipality and Sundays River Valley Local Municipality, Eastern Cape Province. The development area of BP 2 and 3 is completely underlain by the Sundays River Formations. Map drawn QGIS Desktop 2.18.18.

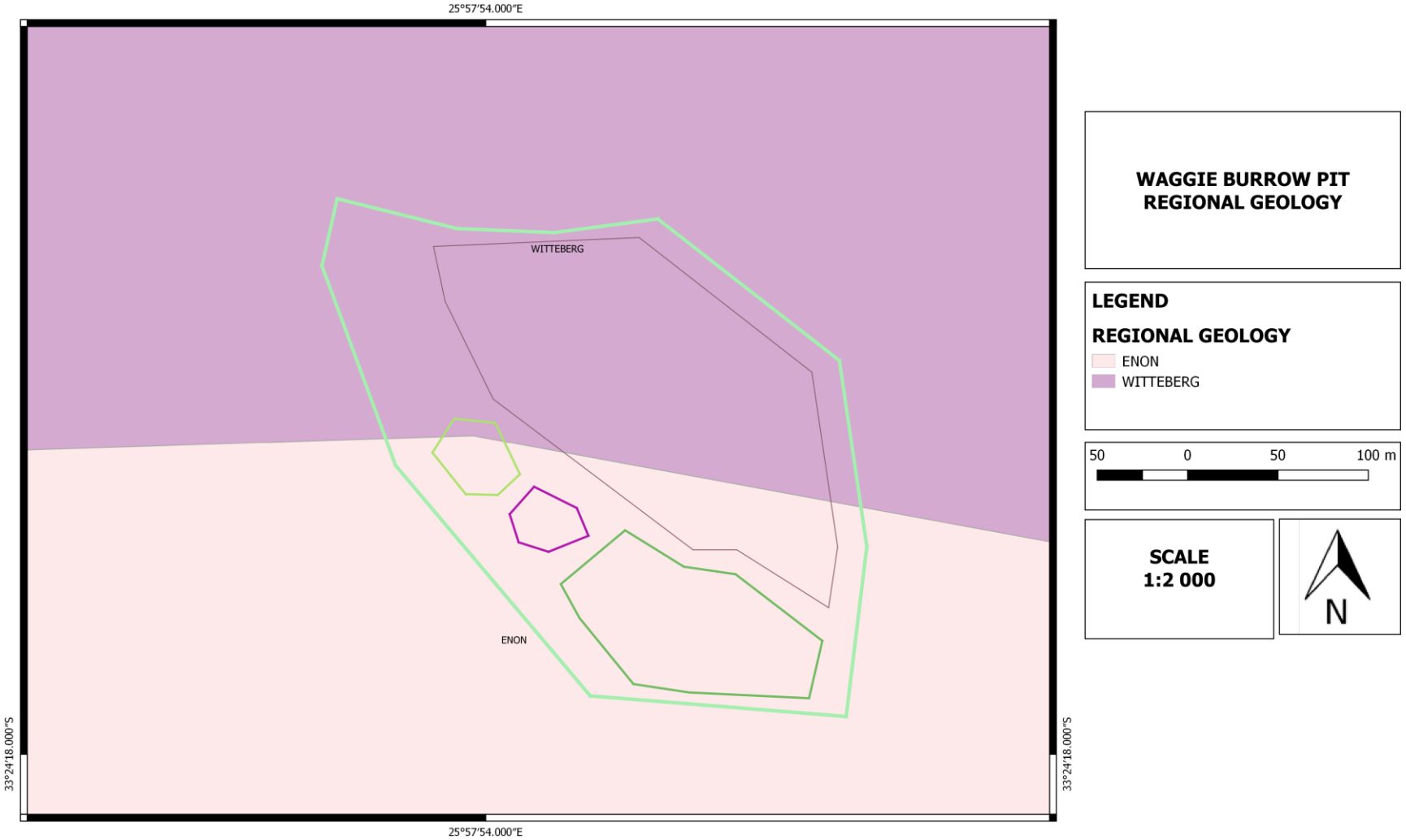


Figure 11. The surface geology of the proposed Waggie BP within the Nelson Mandela Bay Municipality and Sundays River Valley Local Municipality, Eastern Cape Province. The development area is completely underlain by the Witteberg Group of the Cape Supergroup as well as the Enon Formation of the Uitenhage Group. Map drawn QGIS Desktop 2.18.18.

5 GEOGRAPHICAL LOCATION OF THE SITE

Location : Start 33° 47’ 45.01’’ S and 25° 36’ 31.74’’ E
End 33° 34’ 51.97’’ S and 25° 40’ 29.78’’ E
See Map details for the Burrow Pit locations

The proposed development involves the upgrade of approximately 30 km of the MR450 north of WM Maku Street in Motherwell to just south of Addo town. The road will cross the Coega and Sundays River. The three vegetation types (Mucina and Rutherford, 2006) in the proposed upgrade area is:

- Sundays Thicket;
- Coega Bontveld; and,
- Albany Alluvial Vegetation.

6 Methods

As part of the PIA, a field-survey of the development footprint was conducted in July 2018 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot within the proposed development footprint. The results of the field-survey, the author’s experience, aerial photos (using Google Earth, 2018), topographical and geological maps and other reports from the same area were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

1.1 Assumptions and Limitations

The accurateness of PIA is reduced by old fossil databases that do not always include relevant locality or geological formations. The geology in various remote areas of South Africa may be less accurate because it is based entirely on aerial photographs. The accuracy of the sheet explanations for geological maps is inadequate as the focus was never intended to be on palaeontological material.

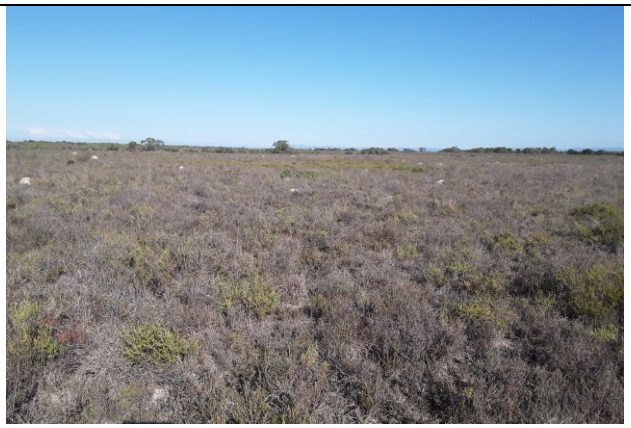
The entirety of South Africa has not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area. Thus, the accuracy of the PIA is improved by a field-survey.

7 FIELD OBSERVATIONS

The following photographs were taken on a site visit to the proposed Motherwell-Addo Road upgrade on 27 July 2018.

33°47'44.93"S 25°36'28.88"E Motherwell road upgrade	
33°44'44.38"S 25°35'37.89"E Motherwell road upgrade	
33°41'32.00"S 25°35'17.00"E PPC1-PPC4 +Stockpile	

33°41'48.64"S 25°35'11.13"E	
33°41'58.63"S 25°35'12.68"E	
33°41'12.26"S 25°36'13.41"E	

33° 34' 44.35”S 25° 37' 33.54”E	
33°40'12.00"S 25°35'30.00"E Motherwell road upgrade	
33°41'18.71"S 25°34'52.87"E PPC1-PPC4 +Stockpile	

33°34'46.79"S 25°37'36.14"E Burrow Pit 3	
33°35'26.00"S 25°38'6.00"E Roadside near Culvert G	
33°35'27.05"S 25°38'3.99"E Roadside near Culvert E Fossiliferous	

33°35'27.05"S 25°38'6.41"E Roadside near Culvert E Sundays River Formation Fossiliferous	
Loose mollusc fossils Sundays River Formation 33°35'27"S 25°38'05E	
33°24'14"S 25°57'48E Waggie Burrow Pit	

8 FINDINGS AND RECOMMENDATIONS

The development area is completely underlain by sediments of the Sundays River, Kirkwood and Enon Formations of the Uitenhage Group, the Witteberg Group of the Cape Supergroup as well as the Algoa Group. During a field survey poorly- to fairly well-preserved loose as well *in situ* fossil assemblages were recorded within the proposed development.

4. *The EAP as well as the ECO for this project must be informed that* sediments of the Sundays River and Kirkwood Formations of the Uitenhage Group, the Witteberg Group of the Cape Supergroup as well as the Algoa Group has a high to very high Palaeontological Sensitivity.
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9 REFERENCES

ALMOND, J.E. 2010. Palaeontological heritage assessment of the Coega IDZ, Eastern Cape Province, 112 pp. Natura Viva cc, Cape Town.

ALMOND, J.E., DE KLERK, W.J. & GESS, R. 2008. Palaeontological heritage of the Eastern Cape. Interim technical report for SAHRA, 25 pp.

DE KLERK, W. J., FORSTER, C. A., ROSS, C. F., SAMPSON, S. D. & CHINSAMY, A. 1998. A review of recent dinosaur and other vertebrate discoveries in the Early Cretaceous Kirkwood Formation in the Algoa Basin, Eastern Cape, South Africa. Journal of African Earth Sciences 27:p55.

DE KLERK, FORSTER, C.A., SAMPSON, S.D., CHINSAMY, A. and ROSS, C.F. 2000. A new coelurosaurian dinosaur from the Early Cretaceous of South Africa. Journal of Vertebrate Paleontology, 20(2), 324-332.

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

HATTINGH, J. 1994. Depositional environment of some gravel terraces in the Sundays River Valley, Eastern Cape. South African Journal of Geology 97, 156-166.

HATTINGH, J. 2001. Late Cenozoic drainage evolution in the Algoa Basin with special refence to the Sundays River Valley. Bulletin 128, 141 pp. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1990a. Algoa Group. In: Johnson, M.R. (Ed.) Catalogue of South African Lithostratigraphic Units, 2, 1-2. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1990b. Palaeontological correlation of Cenozoic marine deposits of the southeastern, southern and western coasts, Cape Province. South African Journal of Geology 93: 514-518.

MACRAE, C. 1999. Life etched in stone. Fossils of South Africa. 305pp. The Geological Society of South Africa, Johannesburg.

MAUD, R.R. & BOTHA, G.A. 2000. Deposits of the South Eastern and Southern Coasts. Pp. 19-32 *in* Partridge, T.C. & Maud, R.R. (Eds). The Cenozoic of Southern Africa. Oxford Monographs on Geology and Geophysics No 40. Oxford University Press. Oxford, New York.

McLACHLAN, I.R. & McMILLAN, I.K. 1976. Review and stratigraphic significance of southern Cape Mesozoic palaeontology. Transactions of the Geological Society of South Africa. 79: 197-212.

ROBERTS, D.L., BOTHA, G.A., MAUD, R.R. & PETHER, J. 2006. Coastal Cenozoic deposits. Pp. 605 – 628 *in* Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria.