PALAEONTOLOGICAL HERITAGE ASSESSMENT: COMBINED DESKTOP & FIELD STUDY

Phase 1 of the proposed Wild Coast Special Economic Zone mixed development near Mthatha Airport, Umtata District, Eastern Cape Province

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EXECUTIVE SUMMARY

Two land parcels totalling 226 hectares situated on the outskirts of Mthatha Airport, Eastern Cape Province, have been selected for development in Phase 1 of the proposed Wild Coast Special Economic Zone (WCSEZ). The two project areas are largely underlain at depth by Early Triassic fluvial sediments of the Katberg Formation (Tarkastad Subgroup, Lower Beaufort Group) with an extensive dolerite intrusion along the southern margin, close to the R61.The sedimentary bedrocks are almost entirely mantled by thick Late Caenozoic soils and gravels as well as alluvium and *vlei* deposits along shallow drainage lines. Elsewhere in the Main Karoo Basin the Katberg Formation has yielded a range of terrestrial fossils assigned to the *Lystrosaurus* Assemblage Zone, including locally abundant skeletal remains and sizeable vertebrate burrows, as well as rare plant material. However, no fossils were recorded from either the bedrocks or superficial sediments during the present site visit.

It is concluded that the impact significance of the proposed development in terms of palaeontological heritage resources is *low*. Confidence levels for this assessment are *medium* due to the very low levels of bedrock exposure in the project area. Pending the potential discovery of significant new fossil remains (*e.g.* vertebrate bones and teeth, burrows, trackways, plant fossils including petrified wood) during the construction phase of the Phase 1 SEZ development, no further specialist palaeontological studies or mitigation are recommended for this project. There are no fatal flaws to the proposed development as far as fossil heritage is concerned. *Provided that* the Chance Fossil Finds Procedure outlined below and tabulated in Appendix 1 is followed through, there are no objections on palaeontological heritage grounds to authorisation of the proposed Phase 1 SEZ development at Mthatha Airport.

The suitably qualified and experienced Environmental Control Officer (ECO) responsible for the construction phase should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible. This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils,

recording of relevant geological data) can be taken by a professional palaeontologist at the proponent's expense. These recommendations are summarized in the tabulated Chance Fossil Finds Procedure appended to this report (Appendix 1).

The palaeontologist concerned with any mitigation work will need a valid fossil collection permit from ECPHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by SAHRA (2013).

1. INTRODUCTION & BRIEF

Two land parcels on the outskirts of Mthatha Airport (Umtata District, Eastern Cape Province) with a combined area of 226 hectares have been selected for Phase 1 of the proposed Wild Coast Special Economic Zone (WCSEZ) mixed development which is being co-ordinated by the Coega Development Corporation (CDC) (Figs. 1 & 2). This first phase will comprise a sector development industrial cluster including a hotel facility supporting both the agriculture sector and tourism (Fig. 3). The remainder of the development will comprise mixed development of industrial platforms, accommodation and commercial platforms and will mainly be financed by private sector. Fourteen priority projects for inclusion in the first phase are as follows:

- A tunnel/hydroponic farming project twenty hectares in extent;
- A vegetable processing and packaging facility three hectares in extent;
- A fresh water fish processing and packaging facility three hectares in extent;
- A meat processing facility three hectares in extent;
- Cold storage facilities suitable for meat, vegetables and fruit eight hectares in extent;
- A fruit processing and packaging facility three hectares in extent;
- An essential oil processing facility three hectares in extent;
- A logistics and distribution facility two hectares in extent;
- Maize storage facilities and silos ten hectares in extent;
- A maize milling facility five hectares in extent; (this will take into consideration existing mills in the area);
- A dairy processing facility with warehousing seven hectares in extent;
- A wool sourcing (inclusive of sorting and classing) facility five hectares in extent;
- A shared administrative and services facility two hectares in extent, and;
- A multi-user agro-processing incubator aimed at smaller and seasonal producers four hectares in extent with innovation and research facilities for the development of new products.

Since the proposed SEZ development will involve excavation into potentially fossiliferous bedrock of the Upper Beaufort Group (Karoo Supergroup), a combined desktop and field-based palaeontological heritage assessment of the Phase 1 project area near Mthatha Airport has been commissioned by WSP, Environment & Energy, Africa (Contact: Ms Ashlea Strong, WSP, Environment & Energy, Africa. Tel: +27 11 361 1392; Fax: +27 11 361 1381; Mobile: +27 82 786 7819).

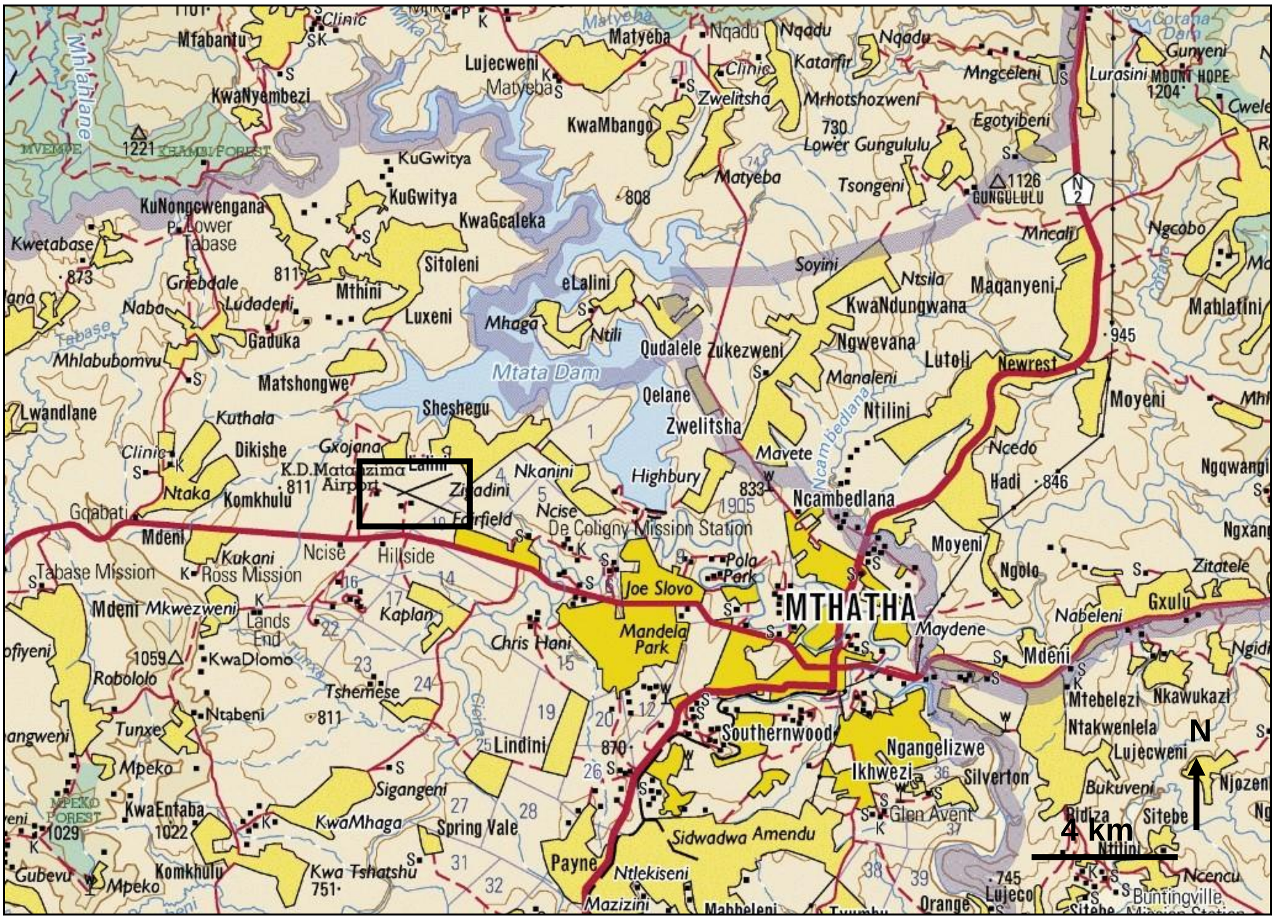

Figure 1. Extract from 1: 250 000 topographic map 3128 Mthatha (Courtesy of the Chief Directorate: National Geo-Spatial Information, Mowbray) showing the location (black rectangle) of the proposed Phase 1 of the Wild Coast SEZ on the outskirts of K.D. Matanzima Airport, *c*. 10 km west of Mthatha, Eastern Cape.

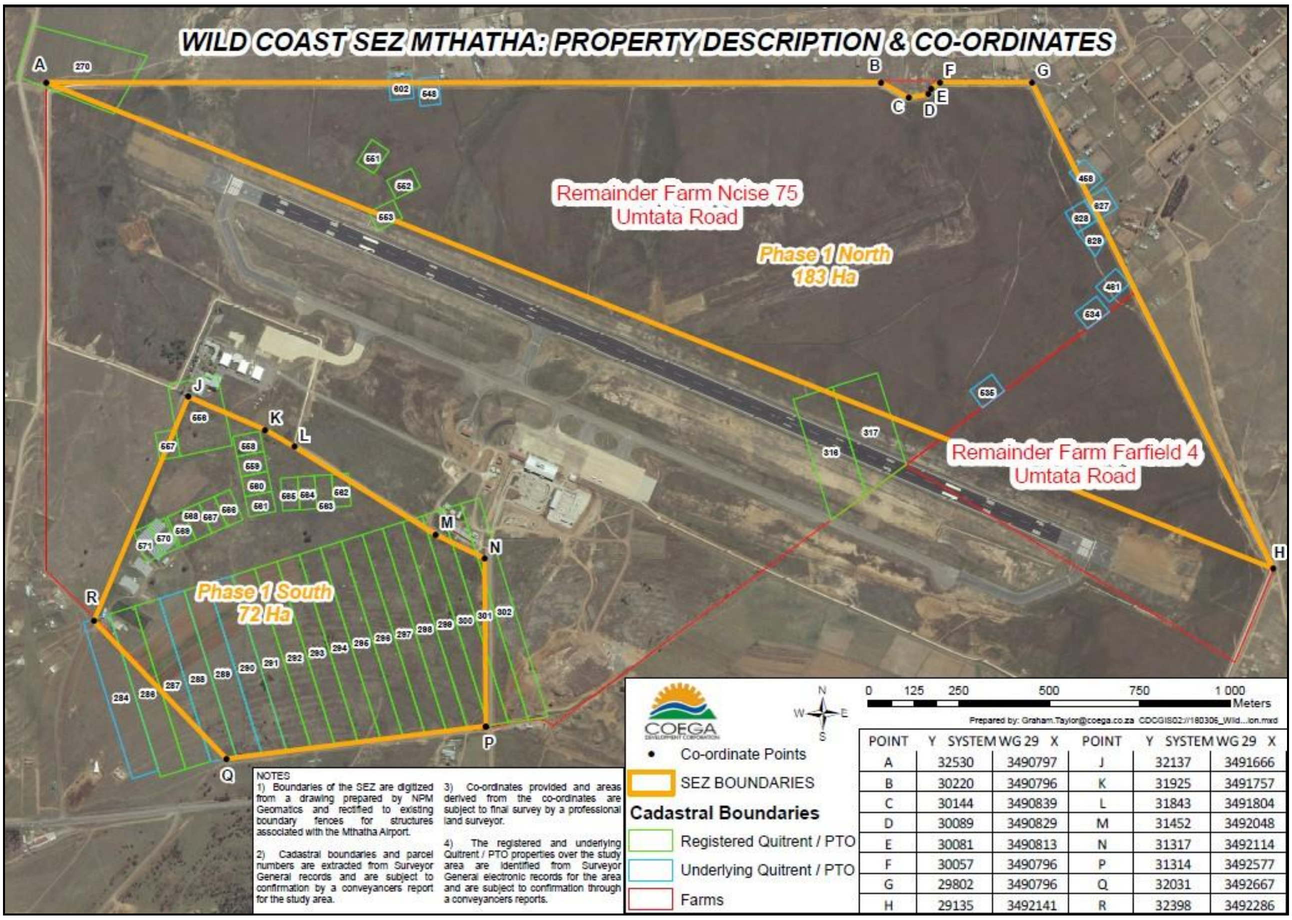

Figure 2. Properties concerned in the Phase 1 Wild Coast SEZ near Mthatha Airport (Image produced by CDC).

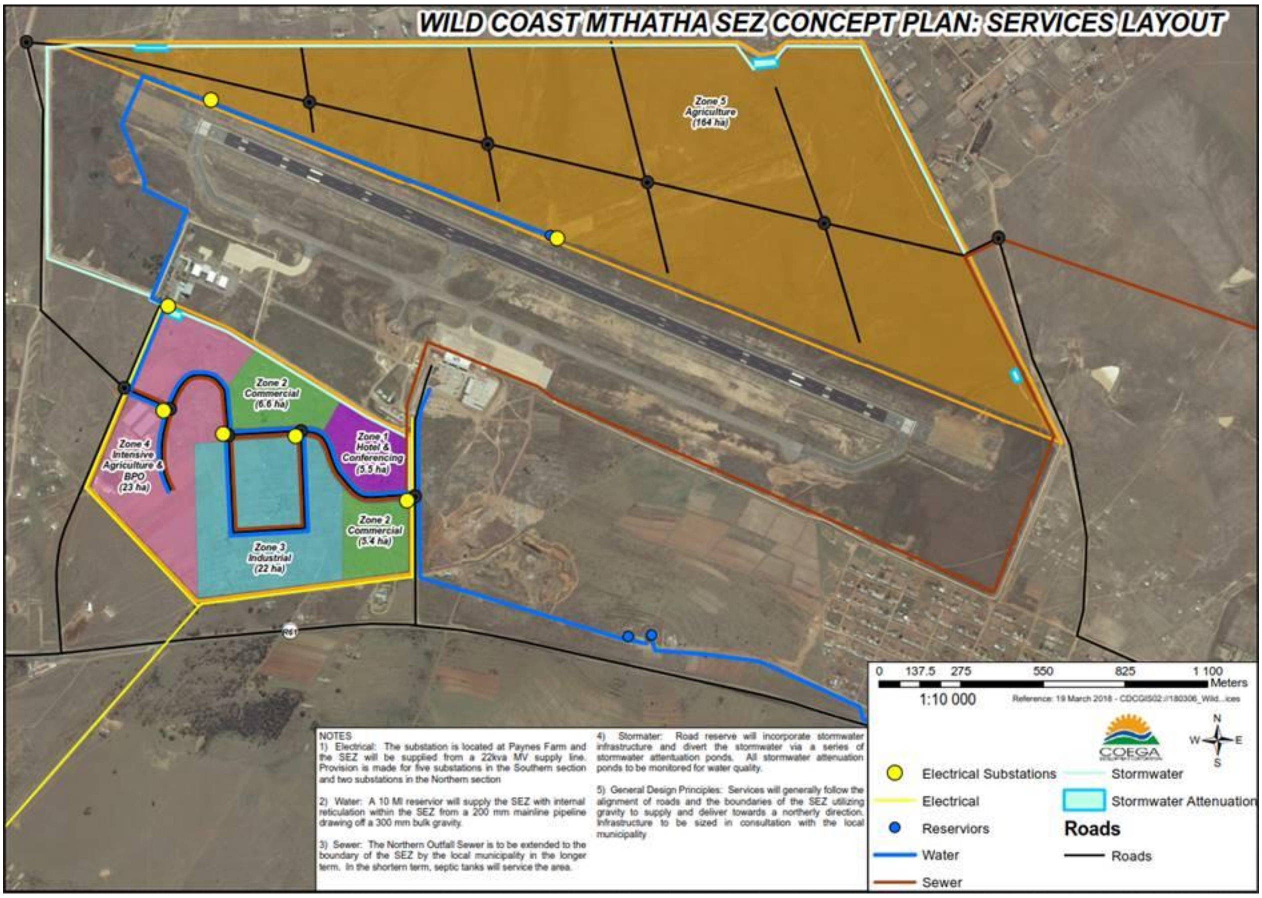

Figure 3. Concept plan showing services for the proposed Phase 1 of the Wild Coast SEZ near Mthatha Airport (Image produced by CDC).

1.1. Legislative context of this palaeontological study

The project area for the Phase 1 Wild Coast SEZ development is situated in an area that is underlain by potentially fossiliferous sedimentary rocks of Early Triassic and Late Caenozoic age (Sections 2 and 3). The development will entail surface clearance and substantial excavations into the superficial sediment cover as well as the underlying bedrock for building foundations, access roads and other services. The development may adversely affect fossil heritage preserved at or beneath the surface of the ground within the footprint by damaging, destroying or disturbing fossils that are then no longer available for scientific research or other public good.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (1999) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:
(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) 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.
(4) No person may, without a permit issued by the responsible heritage resources authority—
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(c) 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
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and
(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports have been developed by SAHRA (2013).

1.2. Approach to the palaeontological heritage assessment

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity to development of each rock unit. Provisional tabulations of palaeontological sensitivity of all formations in Eastern Cape have already been compiled by Almond *et al.* (2008) (See also the SAHRIS Website). The potential impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged.

When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts may occur during the construction, operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority, *i.e.* the Eastern Cape Provincial Heritage Resources Agency, ECPHRA, for the Eastern Cape (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.zaso). It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

1.3. Information sources

The information used in this combined desktop and field assessment was based on the following:

1. Project descriptions, maps and other background documents provided by WSP, Environment & Energy, Africa;

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations (Karpeta & Johnson 1979);

3. The author's database on the geological formations concerned and their palaeontological heritage (*cf* Almond *et al*. 2008);

4. Google Earth© satellite imagery;

5. A short field assessment on 23 July 2018.

1.4. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major

areas of superficial “drift” deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological “grey literature” - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. To the author’s knowledge, there have been no specialist palaeontological field-based studies in this particular part of the Eastern Cape (*cf* vertebrate palaeontology site map in Fig. 21 herein). Since substantial exposures of bedrocks or potentially fossiliferous superficial sediments are not present within the study area, confidence levels for this assessment are rated as *medium*.

Figure 4. Google Earth© satellite image of the area around Mthatha Airport on the northern side of the R61 showing the two land parcels earmarked for Phase 1 of the Wild Coast SEZ (orange polygons). Shallow drainage lines traversing the northern land parcel show up in green. Qy = dolerite quarry.

2. GEOLOGICAL BACKGROUND

The Mthatha Airport project area is situated *c*. 10 km WNW of Mthatha city in undulating hilly terrain at 710 to 790 m amsl between the R61 tar road and the Mthatha Dam (Figs. 1 to 3). Several shallow drainage lines associated with reedy vegetation traverse the area and are especially conspicuous in satellite images of the Phase 1 North area (Fig. 4). Elsewhere almost the entire study area is transformed for agriculture and is mantled with grassy vegetation *plus* a few scattered trees; stepped terraces are present on steeper slopes in the Phase 1 South area (Figs. 12 to 14). An extensive dolerite quarry (Qy in Fig. 4) is located just east of the Phase 1 South area and several other quarries are seen in the broader region.

The geology of the Mthatha Airport study region, situated within the south-eastern sector of the Main Karoo Basin, is shown on 1: 250 000 sheet 3128 Mthatha (Karpeta & Johnson 1979) (Fig. 5). Most of the SEZ Phase 1 project area is underlain by Early Triassic (*c*. 250 Ma = million years old) fluvial sediments of the **Katberg Formation** (**TRk**, yellow with red stipple in Fig.5) which forms the lowermost subunit of the Tarkastad Subgroup (Upper Beaufort Group, Karoo Supergroup) (Fig. 6). The overlying Burgersdorp Formation crops out just to the west according to the geological map so it is possible that sandstone-dominated Katberg facies and mudrock-dominated Burgersdorp facies interfinger in this area (See Fig. 7). Levels of tectonic deformation in the region are low, with most of the Karoo Supergroup succession being subhorizontal. The southern part of the project area, closer to the R61, overlies an Early Jurassic intrusive sill of the **Karoo Dolerite Suite** whose outcrop runs well to the south, in part along the contact between the Katberg and Burgersdorp Formations. The thick dolerite intrusion is deeply weathered to crumbly, khaki-grey *sabunga*, as well seen in the main quarry area (Fig. 8). Baking of Katberg country rocks to quartzite and hornfels along intrusive contacts can be expected in the subsurface here. Levels of bedrock exposure throughout the study area are very poor due to a thick mantle of colluvial to alluvial gravels and soil as well as pervasive grassy vegetation (Figs. 4, 12 to 14).

Useful geological descriptions of the predominantly braided fluvial deposits of the Katberg Formation are given by Johnson (1976), Hancox (2000), Johnson *et al.* (2006), Smith *et al.* (2002) and for the Mthatha sheet area in particular by Karpeta and Johnson (1979). More detailed sedimentological accounts are provided by Stavrakis (1980), Hiller and Stavrakis (1980, 1984), Haycock *et al.* (1994), Groenewald (1996), Neveling (1998) and Pace *et al.* (2009) (Fig. 7). The Katberg Formation forms the regionally extensive, sandstone-rich lower portion of the mainly fluvial Tarkastad Subgroup (Upper Beaufort Group) that can be traced throughout large areas of the Main Karoo Basin. Its thickness in the Mthatha 1: 250 000 sheet area is not recorded by Karpeta and Johnson (1979) but further west within the Eastern Cape it reaches a maximum thickness of some 400 m, while thicknesses of 240-260 m are more usual. The predominantly braided fluvial Katberg succession comprises (a) prominent-weathering, pale buff to greyish, tabular or ribbon-shaped sandstones up to 60 m thick that are interbedded with (b) recessive-weathering, reddish or occasionally green-grey mudrocks. Up to four discrete sandstone packages can be identified within the succession. Katberg channel sandstones are typically rich in feldspar and lithic grains (*i.e*. lithofeldspathic). They build laterally extensive, tabular, multi-storey units with an erosional base that is often marked by intraformational conglomerates up to one meter or more thick consisting of mudrock pebbles, reworked calcrete nodules and occasional rolled fragments of bone. While the basal Katberg succession is often marked by a major cliff-forming sandstone unit, in some areas there is a transitional relationship with the underlying Adelaide Subgroup that is marked by a broadly upward-thickening series of sandstone sheets. Cliff-forming outcrops of the Katberg Formation are composed of amalgamated channel sandstone facies with only a small proportion of overbank mudrocks. Internally the moderately well-sorted sandstones are variously massive, horizontally-laminated or tabular to trough cross-bedded while heavy mineral laminae occur frequently. Sphaeroidal carbonate concretions up to 10 cm across, sometimes secondarily ferruginised, are common. The predominantly purple-brown Katberg mudrocks are typically massive with horizons of pedocrete nodules (calcretes) and mudcracks but packages of thin-bedded grey-green and purple-brown mudrocks passing up into heterolithic successions of thinly interbedded grey-green fine sandstone and siltstone are also occasionally seen.

Mudrock as well as sandstone exposure within the present study area is very limited indeed due to extensive mantling of these recessive-weathering rocks by superficial sediments (soils, scree, downwasted gravels, hillwash *etc*). The only examples of Katberg bedrocks encountered during the field survey comprised excavated blocks of khaki-green, finely-laminated sandstone and slickensided grey-green siltstone along the northern perimeter of the Phase 1 North area (Fig. 16). Extensive road cuttings through Katberg sandstones are seen along the R61 some 5 km ESE of the airport. They comprise a thick package of brown-weathering, medium- to thick-bedded, medium-grained sandstones with erosional bases and horizons with irregular rounded hollows probably representing weathered-out carbonate concretions (Fig. 17).

Thick Late Caenozoic alluvial deposits are associated with the Mthatha River and its major tributaries to the north of the project area but are not mapped within the area itself (Fig. 5). However, modest thicknesses of alluvial gravels, sands and muds as well as muddy *vlei* deposits may be expected along the small drainage lines seen here (*e.g.* in Phase 1 North area, Figs. 4 & 15). Elsewhere basal doleritic and sandstone gravels and overlying brownish sandy to silty soils with sparse gravels – including occasional hornfels stone artefacts - are locally exposed in small-scale erosion gullies and artificial excavations (Figs. 10, 1l, 19). Overlying the dolerite outcrop in the Phase 1 South area the soils are markedly ferruginous and reddened (lateritic) with frequent development of fine ferricrete glaebules in the subsoil (Figs. 9 & 11). Several exposures of massive, poorly-sorted gravelly to sandy deposits seen in the airport vicinity may represent artificially reworked rock rubble rather than natural alluvial or colluvial sediments (Figs. 18 & 20).

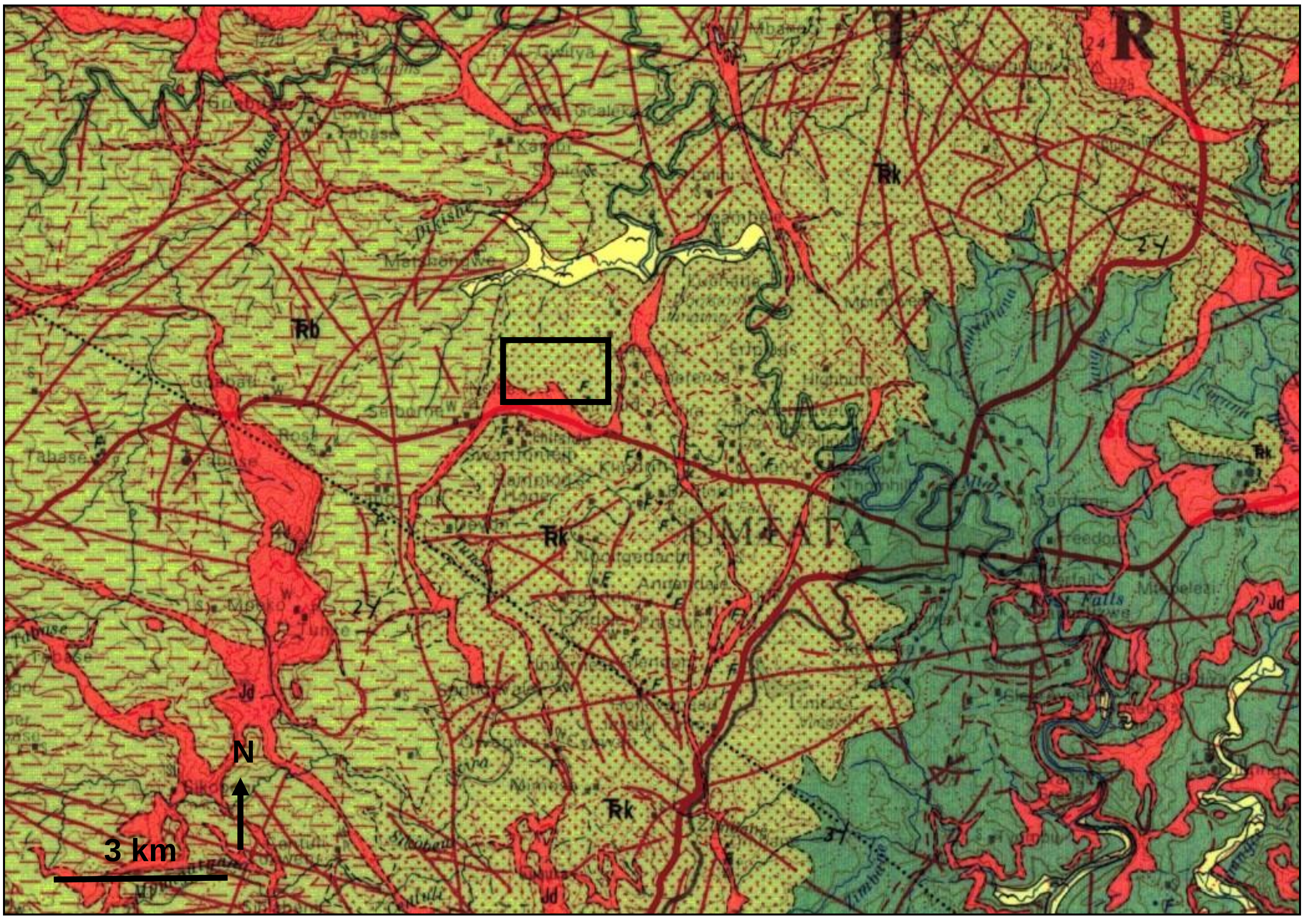

Figure 5. Extract from 1: 250 000 geology sheet 3128 Mthatha (Council for Geoscience, Pretoria) showing *approximate* location of the Phase 1 Wild Coast SEZ project area near Mthatha Airport, Eastern Cape (black rectangle).

The main geological units represented here are:

Pa (pale blue) = Late Permian to Earliest Triassic Adelaide Subgroup (Lower Beaufort Group, Karoo Supergroup)
TRk (green with red stipple) = Early Triassic Katberg Formation (Tarkastad Subgroup / Upper Beaufort Group, Karoo Supergroup)
TRb (gree with red dashes) = Early Triassic Burgersdorp Formation (Tarkastad Subgroup).
Jd (red) = Early Jurassic Karoo Dolerite Suite
Pale yellow areas with “flying bird”symbol = Quaternary to Recent alluvium
***N.B.* Other Caenozoic superficial deposits such as colluvium (scree *etc*), soils and surface gravels are not depicted here but in fact cover much of the landscape.**

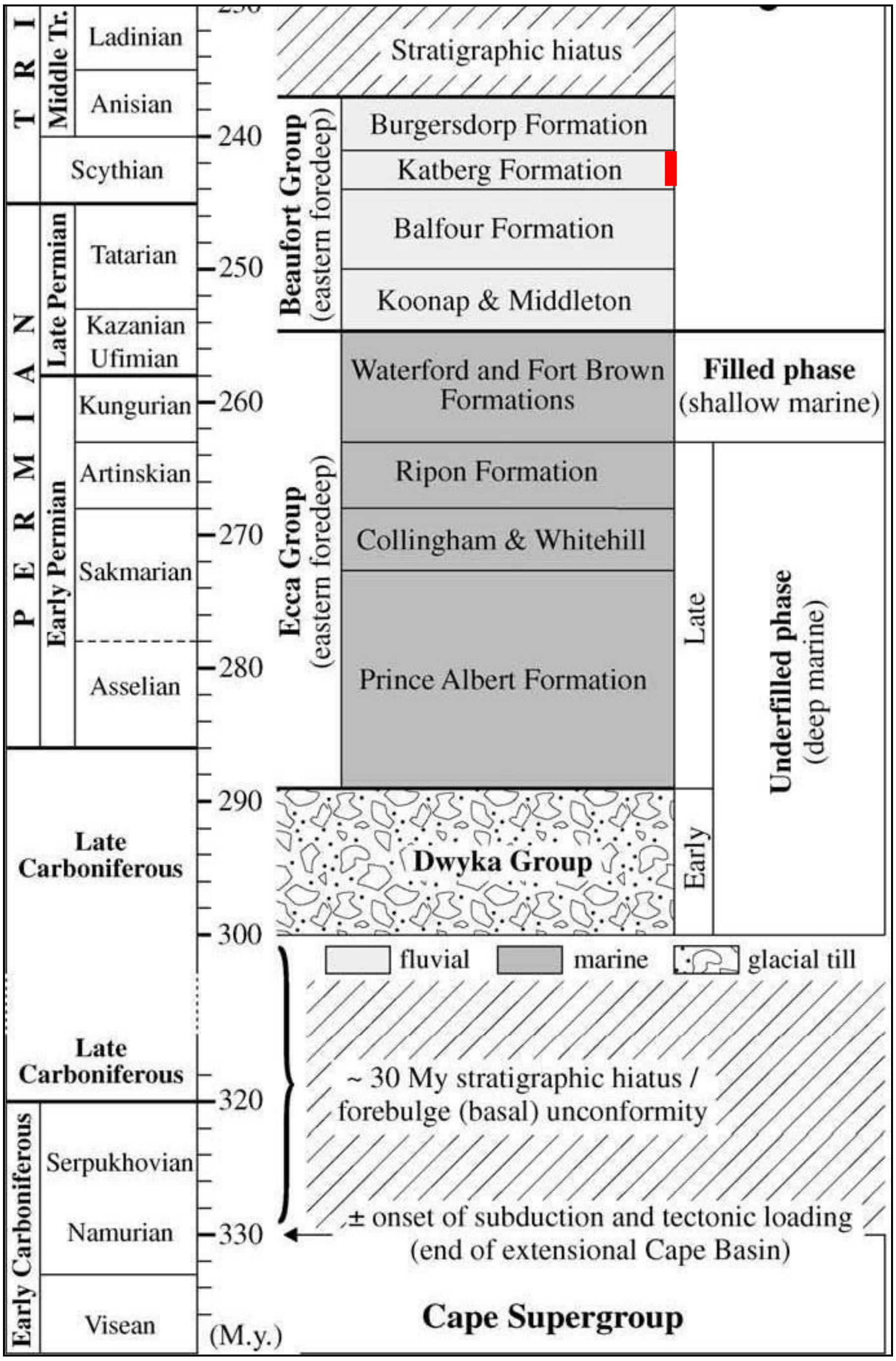

Figure 6. Stratigraphic subdivision of the Carboniferous and Permian portions of the Karoo Supergroup in the Main Karoo Basin (From Catuneanu *et al.* 2005). The Early Triassic Katberg Formation within the Upper Beaufort Group (Tarkastad Subgroup) that is represented within the Phase 1 Wild Coast SEZ project area is emphasized by the thick red bar.

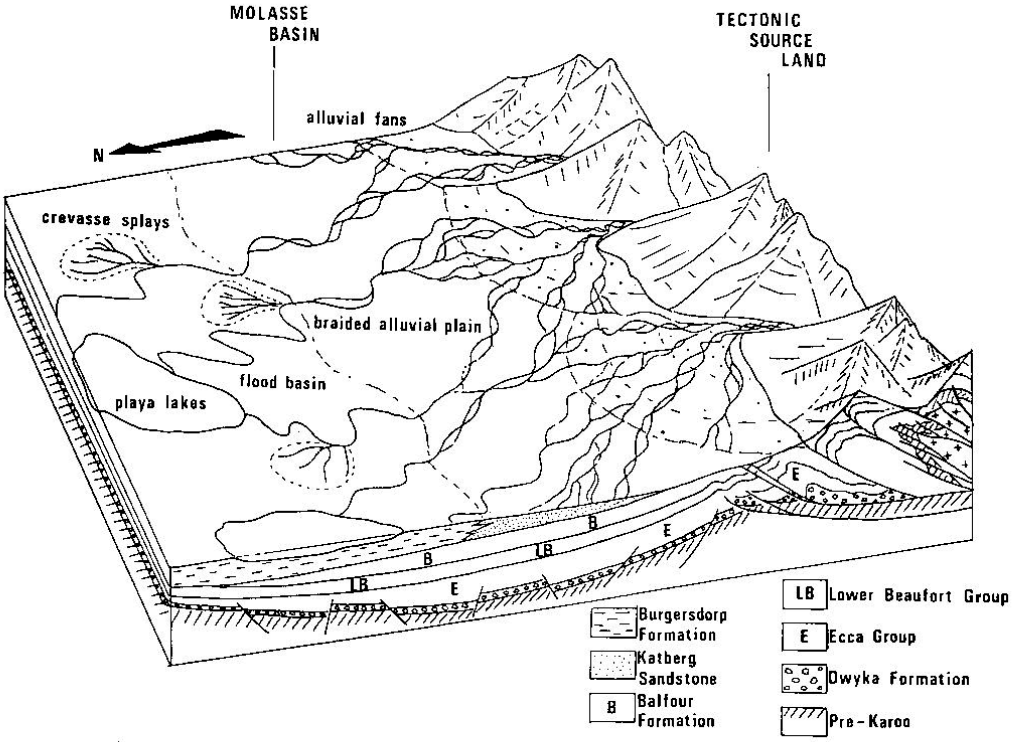

Figure 7. Reconstruction of the south-eastern Main Karoo Basin in Early Triassic times showing the deposition of the sandy braided fluvial Katberg Formation near the mountainous source area in the south. The mudrock-dominated Burgersdorp Formation was deposited on the distal floodplain where numerous playa lakes are also found (From Hiller & Stavrakis 1984).

Figure 8. Cut face of the hard rock quarry situated just east of the Phase 1 South Area showing deeply-weathered dolerite *sabunga* capped by lateritic saprolite and brown soils.

Figure 9. Close-up of reddened lateritic soils overlying the weathered dolerite outcrop in the dolerite quarry east of Phase 1 South Area.

Figure 10. Farm track traversing the Phase 1 South Area showing dolerite rubble underlying thin brownish soils.

Figure 11. Excavations into thick reddish soils along the eastern edge of the Phase 1 South Area showing small, rounded ferricrete glaebules weathering out of the subsoil profile. Sparse hornfels stone artefacts were recorded within disturbed soils here.

Figure 12. Terraced N-facing grassy hillslopes in the Phase 1 South Area, probably underlain at depth by dolerite.

Figure 13. View towards the ESE across the Phase 1 North Area showing undulating grassy terrain with no bedrock exposure. The round reservoir on the skyline lies near the R61.

Figure 14. View southwards across the Phase 1 North Area from the airport perimeter road towards the main airport buildings.

Figure 15. Tall grassy vegetation and reeds marking one of several winding drainage lines traversing the Phase 1 North Area (See aerial view in Fig. 4). Bedrock or alluvial sediments are not well-exposed along such shallow, vegetated drainage lines.

Figure 16. Excavated brown-patinated, angular blocks of grey to khaki sandstones of the Katberg Formation encountered adjacent to the northern airport perimeter road.

Figure 17. R61 road cutting through medium-bedded, tabular, brown-weathering sandstones of the Katberg Formation showing horizon of weathered-out carbonate concretions (Hammer = 30 cm) (Locality lies *c*. 5 km ESE of airport terminal).

Figure 18. Gravelly mudrock debris exposed along a drainage line crossing the Phase 1 North Area – probably an artificial deposit related to adjacent road or drainage works.

Figure 19. Thick, pale grey-brown sandy soils exposed on the edges of a shallow erosion gulley, Phase 1 North Area.

Figure 20. Massive, gullied deposit of sandy to gravelly material and ferricrete glaebules on a steep S-facing scarp just north of the airport runway – probably a result of airport construction activities and not a natural deposit.

3. PALAEONTOLOGICAL HERITAGE

The Katberg Formation is considered to be palaeontologically highly sensitive based on the important post-extinction continental biotas of Early Triassic age recorded from this unit in the Main Karoo Basin (SAHRIS website). A compilation map of known fossil vertebrate sites from the Beaufort Group of the Main Karoo Basin (Nicolas 2007) emphasises the lack of records from the former Transkei region including the Mthatha area (Fig. 21). Rather than simply due to a lack of fossils here, the main reasons are probably low levels of surface exposure (soil, colluvial, alluvial and vegetation cover), high levels of subsurface humid climate weathering, as well as the paucity of palaeontological field studies in the region.

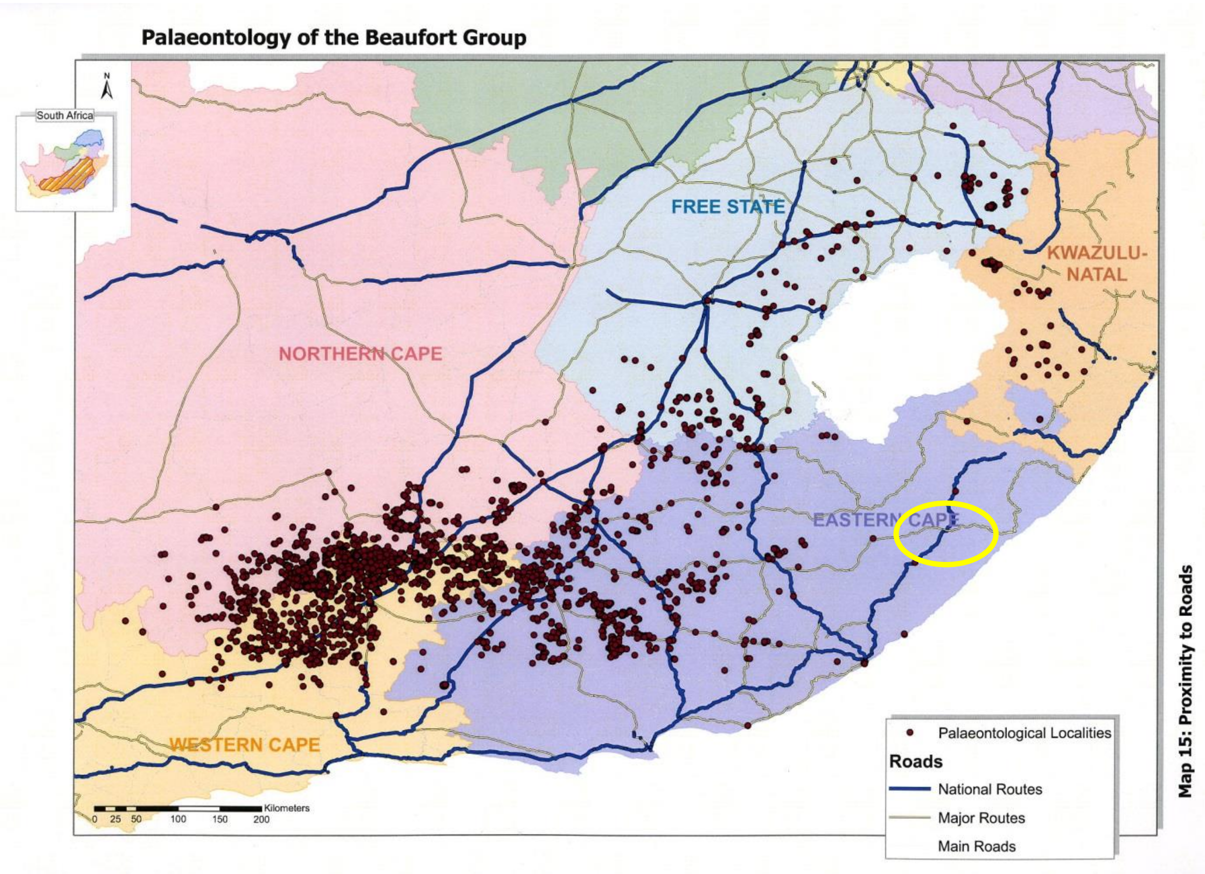

Figure 21. Distribution of recorded fossil vertebrate localities within the Beaufort Group (Main Karoo Basin) showing the lack of sites in the poorly-studied former Transkei region, including the Mthatha area (yellow ellipse) (Map abstracted from Nicolas 2007).

The Katberg Formation is known to host a diverse and palaeontologically important terrestrial fossil biota of Early Triassic (Scythian / Induan - Early Olenekian) age, *i.e.* around 252 million years old (Groenewald & Kitching 1995, Rubidge 2005, Smith *et al.* 2012). The biota is dominated by a range of therapsids ("mammal-like reptiles"), amphibians and other tetrapods, with rare vascular plants and trace fossils, and has been assigned to the ***Lystrosaurus* Assemblage Zone** (**LAZ**). This surprisingly rich fossil assemblage characterizes Early Triassic successions of the upper part of the Palingkloof Member (Adelaide Subgroup) as well as the Katberg Formation. It should also be noted that while the dicynodont *Lystrosaurus* is also recorded from the uppermost beds of the Latest Permian *Daptocephalus* Assemblage Zone it only becomes super-abundant in Early Triassic times (*e.g.* Smith & Botha 2005, Botha & Smith 2007 and refs. therein).

Useful illustrated accounts of LAZ fossils are given by Kitching (1977), Keyser and Smith (1977-1978), Groenewald and Kitching (1995), MacRae (1999), Hancox (2000), Smith *et al.* (2002), Cole *et al*. (2004), Rubidge (2005 *plus* refs therein), Damiani *et al.* (2003a) and Smith *et al.* (2012) among others. These fossil biotas are of special palaeontological significance in that they document the recovery phase of terrestrial ecosystems following the catastrophic end-Permian Mass Extinction of 252 million years ago (*e.g.* Smith & Botha 2005, Gastaldo *et al.* 2005, Botha & Smith 2007, Smith & Botha-Brink 2014 and refs. therein). They also provide interesting insights into the adaptations and taphonomy of terrestrial animals and plants during a particularly stressful, arid phase of Earth history in the Early Triassic.

Key tetrapods in the *Lystrosaurus* Assemblage Zone biota are various species of the medium-sized, shovel-snouted dicynodont *Lystrosaurus* (by far the commonest fossil form in this biozone. contributing up to 95% of fossils found), the small captorhinid parareptile *Procolophon*, the crocodile-like early archosaur *Proterosuchus*, and a wide range of small to large armour-plated "labyrinthodont" amphibians such as *Lydekkerina* (Figs. 22 and 23). Botha and Smith (2007) have charted the ranges of several discrete *Lystrosaurus* species either side of the Permo-Triassic boundary. Also present in the LAZ are several genera of small-bodied true reptiles (*e.g.* owenettids), therocephalians, and early cynodonts (*e.g. Galesaurus, Thrinaxodon*). Animal burrows are attributable to various aquatic and land-living invertebrates, including arthropods (*e.g. Scoyenia* and *Katbergia* scratch burrows), as well as several subgroups of fossorial tetrapods such as cynodonts, procolophonids and even *Lystrosaurus* itself (*e.g.* Groenewald 1991, Groenewald *et al.* 2001, Damiani *et al.* 2003b, Abdala *et al.* 2006, Modesto & Brink 2010, Bordy *et al.* 2009, 2011, Krummeck & Bordy 2016, Bordy & Krummeck 2016, Bordy (Ed.) 2017). Vascular plant fossils are generally rare and include petrified wood ("*Dadoxylon*") as well as leaves of glossopterid progymnosperms and arthrophyte ferns (*Schizoneura*, *Phyllotheca*). An important, albeit poorly-preserved, basal Katberg palaeoflora has recently been documented from the Noupoort area (Carlton Heights) by Gastaldo *et al.* (2005). Plant taxa here include sphenopsid axes, dispersed fern pinnules and possible peltasperm (seed fern) reproductive structures. Pebbles of reworked silicified wood of possible post-Devonian age occur within the Katberg sandstones in the proximal outcrop area near East London (Hiller & Stavrakis 1980, Almond unpublished obs.). Between typical fossil assemblages of the *Lystrosaurus* and *Cynognathus* Assemblage Zones lies a possible *Procolophon* Acme Zone characterized by abundant material of procolophonids and of the amphibian *Kestrosaurus* but lacking both *Lystrosaurus* and *Cynognathus* (Hancox 2000 and refs. therein).

Most vertebrate fossils are found in the mudrock facies rather than channel sandstones. Articulated skeletons enclosed by calcareous pedogenic nodules are locally common, while intact procolophonids, dicynodonts and cynodonts have been recorded from burrow infills (Groenewald and Kitching, 1995). Fragmentary rolled bone and teeth (*e.g.* dicynodont tusks) are found in the intraformational calcrete nodule conglomerates at the base of some the channel sandstones. Vertebrate burrows occur within both mudrock and sandstone facies.

Karpeta and Johnson (1979) refer to rare plant fragments and terrestrial vertebrate remains in the Tarkastad Subgroup of the 1: 250 000 Umtata geological sheet area while a number of *Lystrosaurus* Assemblage Zone fossils, including several therapsids and numerous vertebrate burrows, have recently been recorded from the Katberg Formation and uppermost Adelaide Subgroup in the Mbashe River Valley region.

The **Karoo dolerites** are igneous rocks, intruded at depth within the crust, and therefore do not contain fossils. The preservation of fossils preserved within the aureoles of dolerite intrusions may be variously enhanced or compromised by thermal metamorphism and secondary mineralisation.

Late Caenozoic superficial deposits of the Karoo region are poorly studied in palaeontological terms but may contain local concentrations of fossil vertebrate, invertebrate and plant remains as well as trace fossils (*e.g.* mammalian bones, teeth, horncores, freshwater or terrestrial molluscs, coalified wood, palynomorphs, calcretised root casts and termitaria) (*cf* Skead 1980, Klein 1984, MacRae 1999, Brink & Rossouw 2000, Churchill *et al.* 2000, Partridge & Scott 2000). Key fossiliferous facies are mostly associated with extant or defunct drainage lines and include older consolidated alluvium and terrace gravels, lake, pan and *vlei* deposits (Partridge *et al.,* 2006). The Pleistocene to Holocene **Masotcheni Formation**, for example, is often characterised by concentrations of petrified fossil wood reworked from the Karoo Supergroup bedrocks as well as Early to Middle Stone Age stone artefacts.

No fossil remains were recorded from the Katberg Formation bedrocks or from the overlying superficial deposits in the Mthatha Airport area during the present field survey. This may be largely attributable to the paucity of bedrock exposure here, but deep chemical weathering of the bedrocks (as exemplified by the dolerites) as well as thermal metamorphism by large dolerite intrusions may also have compromised fossil preservation.

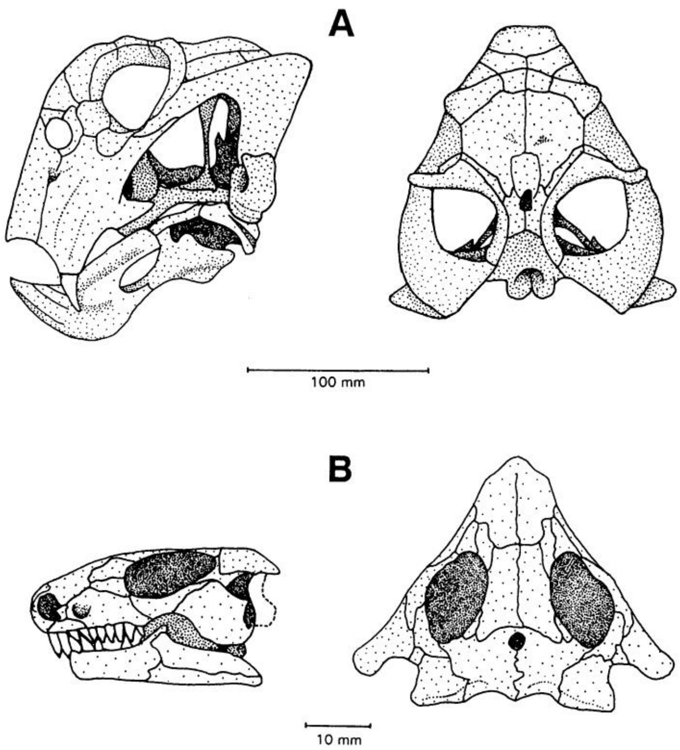

Figure 22. Skulls of two key tetrapod genera from the Early Triassic *Lystrosaurus* Assemblage Zone of the Main Karoo Basin: the pig-sized dicynodont *Lystrosaurus* (A) and the small primitive reptile *Procolophon* (B) (From Groenewald and Kitching, 1995).

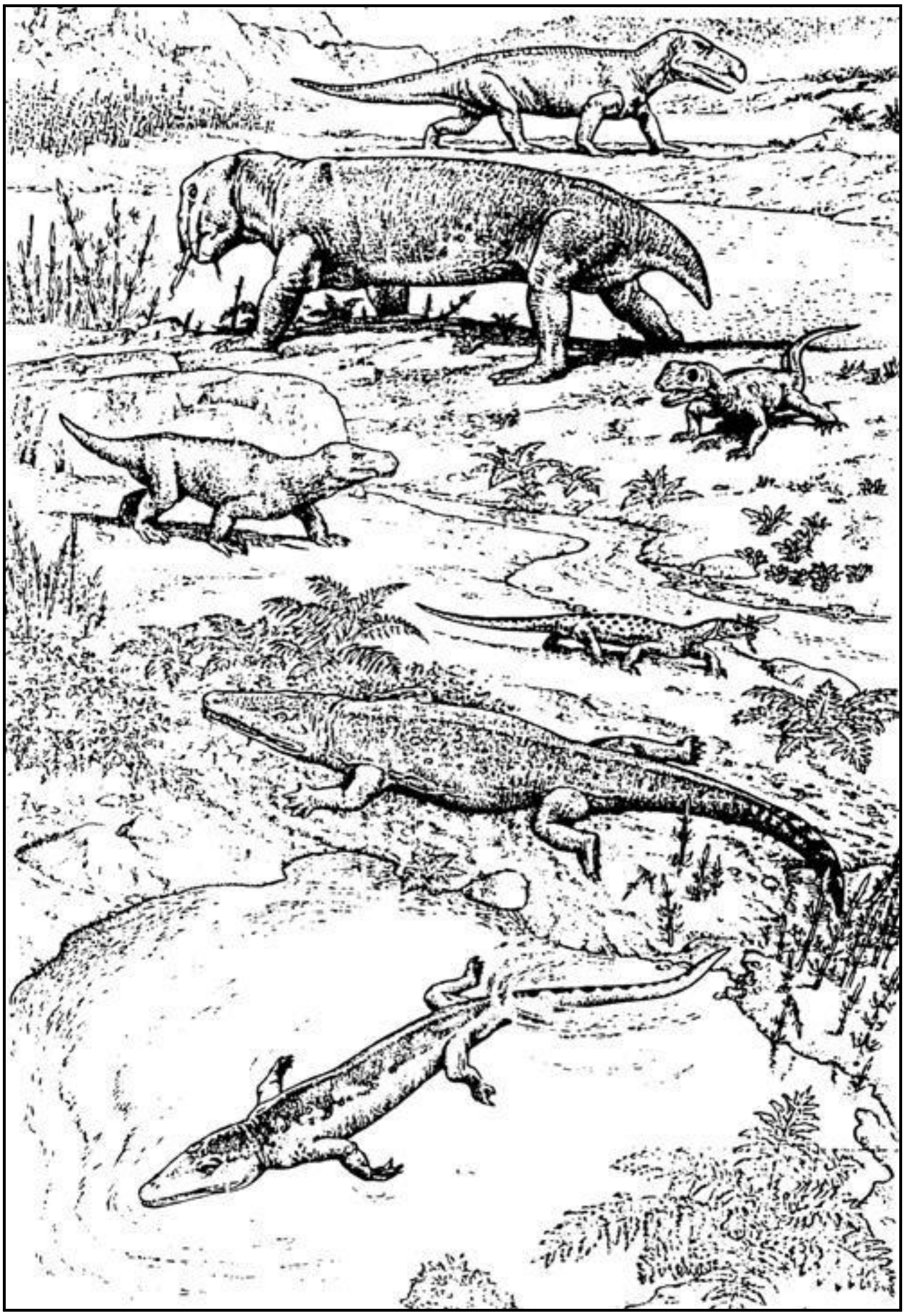

Figure 23. Reconstruction of Early Triassic biotas of the *Lystrosaurus* Assemblage Zone (From Benton 2003 *When life nearly died*). Animals illustrated here include the crocodile-like archosaur reptile *Proterosuchus* (top) and below this the dominant, pig-sized dicyndont *Lystrosaurus*, a small predatory therocephalian therapsid (middle left), several small lizard-like reptiles such as procolophonids (middle right), and two large amphibians (bottom). Plants shown here include several ferns and reedy horsetails.

4. CONCLUSIONS & RECOMMENDATIONS

The Phase 1 SEZ project areas adjacent to Mthatha Airport are largely underlain by Early Triassic fluvial sediments of the Katberg Formation (Tarkastad Subgroup, Lower Beaufort Group) with an extensive dolerite intrusion along the southern margin, close to the R61.The sedimentary bedrocks are almost entirely mantled by thick Late Caenozoic soils and gravels as well as alluvium and *vlei* deposits along shallow drainage lines. Elsewhere in the Main Karoo Basin the Katberg Formation has yielded a range of terrestrial fossils assigned to the *Lystrosaurus* Assemblage Zone, including locally abundant skeletal remains and sizeable vertebrate burrows, as well as rare plant material. However, no fossils were recorded from either the bedrocks or superficial sediments during the present site visit.

So far, very few fossil vertebrate remains, or other palaeontological material, have been recorded from the Karoo Supergroup rocks in the Mthatha area of the former Transkei (Nicolas 2007). This may well be attributed in large part to (1) generally low levels of fresh bedrock exposure here, mainly due to the thick mantle of superficial deposits (colluvium / alluvium / soils) as well as seasonally dense vegetation cover, (2) protracted deep weathering of bedrocks in humid, pluvial climates, (3) baking of sedimentary country rocks by extensive dolerite intrusion, and (4) the paucity of palaeontological field studies in the region. However, where bedrock exposure is good – as along the Mbashe River Valley – vertebrate material has been found during recent field surveys.

It is concluded that the impact significance of the proposed development in terms of palaeontological heritage resources is *low*. Confidence levels for this assessment are *medium* due to the very low levels of bedrock exposure in the project area. Pending the potential discovery of significant new fossil remains (*e.g.* vertebrate bones and teeth, burrows, trackways, plant fossils including petrified wood) during the construction phase of the Phase 1 SEZ development, no further specialist palaeontological studies or mitigation are recommended for this project. There are no fatal flaws to the proposed development as far as fossil heritage is concerned. *Provided that* the Chance Fossil Finds Procedure outlined below and tabulated in Appendix 1 is followed through, there are no objections on palaeontological heritage grounds to authorisation of the proposed Phase 1 SEZ development at Mthatha Airport.

The suitably qualified and experienced Environmental Control Officer (ECO) responsible for the construction phase should be made aware of the potential occurrence of scientifically-important fossil remains within the development footprint. During the construction phase all major clearance operations and deeper (> 1 m) excavations should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains be encountered at surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the Eastern Cape Provincial Heritage Resources Agency, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za) as soon as possible. This is to ensure that appropriate action (*i.e.* recording, sampling or collection of fossils, recording of relevant geological data) can be taken by a professional palaeontologist at the proponent's expense. These recommendations are summarized in the tabulated Chance Fossil Finds Procedure appended to this report (Appendix 1).

The palaeontologist concerned with any mitigation work will need a valid fossil collection permit from ECPHRA and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection). All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by SAHRA (2013).

These monitoring and mitigation recommendations are to be incorporated into the Environmental Management Programme (EMPr) for the Phase 1 SEZ development. It should be emphasized that, *providing appropriate mitigation is carried out*, the majority of developments involving fossiliferous bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

5. ACKNOWLEDGEMENTS

Ms Ashlea Strong of WSP, Environment & Energy, Africa is thanked for commissioning this study and for providing the necessary background information. Further project information was kindly provided by her colleague Mr Tutayi Chifadza. I would also like to thank Mr Paulin Naidoo (Mthatha Airport Manager) and Ms Princess Kabeni (Airport Security Manger) for facilitating my site visit, as well as Mr Donald Nomandindi (Security Guard) for accompanying me in the field.

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7. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Northwest, Mpumalanga, KwaZulu-Natal and the Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has previously served as a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed water development projects, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**

<table>
<tr><td colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Phase 1 of the Wild Coast Special Economic Zone, Mthatha Airport</td></tr>
<tr><td>Province & region:</td><td colspan="2">EASTERN CAPE, Umtata District</td></tr>
<tr><td>Responsible Heritage Resources Authority</td><td colspan="2">ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; smokhanya@ecphra.org.za)</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Katberg Formation (Tarkastad Subgroup, Karoo Supergroup), Late Caenozoic superficial deposits</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Fossil bones, teeth, burrows and trackways of Triassic vertebrates, petrified wood and other plant material. Fossil teeth, bones and horncores of mammals in Pleistocene colluvial and alluvial deposits.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Authority for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Authority, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
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