

## **PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY**

# **Proposed rezoning and possible subdivision of Portion 72 (Portion of Portion 1) of Farm 485 Stades River near Beachview, Uitenhage Division, Eastern Cape Province**

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**March 2011**

### **1. SUMMARY**

The study area on Farm 485 Stades River is situated just east of the Maitland River Mouth, on the south coast some 30km west of Port Elizabeth city centre. It is largely underlain by Late Pliocene to Holocene coastal aeolianites of the Nanaga and Schelm Hoek Formations (Algoa Group) that are in general only sparsely fossiliferous. Highly-deformed Late Precambrian sediments of the Kleinrivier Formation (Gamtoos Group) crop out along the adjacent coast and underlie the study area at depth. Simple organic-walled microfossils (acritarchs) of Ediacaran (*ie* latest Precambrian) age have recently been described from this formation, but there are no records of macrofossils. The palaeontological sensitivity of the Gamtoos Group as a whole is rated as low.

Given the low palaeontological sensitivity of the rock units concerned, there are no objections to the proposed development on palaeontological grounds, and no further palaeontological mitigation is recommended. However, should substantial fossil remains, such as mammalian bones and teeth or dense shell beds, be exposed during excavations, these should be recorded and safeguarded by the ECO responsible. The ECO should also notify SAHRA at the earliest opportunity so that any appropriate mitigation can be implemented, at the developer's expense.

### **2. INTRODUCTION & BRIEF**

It is proposed to rezone and possibly subdivide Portion 72 (Portion of Portion 1) of the Farm Stades River No. 485 in the Division of Uitenhage, Eastern Cape Province for residential purposes. The development site is 16.3ha in area and is situated adjacent to and north of Beachview Road, c. 3km east of Maitland River Mouth (Figs. 1 and 2).

According to the BID document prepared by CEN EIM Unit, Port Elizabeth:

Sections of the northern portion of the site have been used for agricultural activities in the past and have been cleared of the original vegetation Sardinia Bay Forest Thicket vegetation. Informal walking paths have been cleared through the site, and it is bordered on the northern side by an access road. The remainder of the site is covered in relatively undisturbed coastal forest.

The study area is underlain by potentially fossiliferous rocks of the Late Cenozoic Algoa Group. A palaeontological desktop study for this project has been requested by SAHRA in accordance with the requirements of the National Heritage Resources Act, 1999 (NHRA). This report has therefore been commissioned on behalf of Alex McLeod by Ms Belinda Clark of the CEN Integrated Environmental Management Unit, Port Elizabeth.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and protected by this act, include, among others:

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

Section 35 of the NHRA further states that:

(1) The protection of palaeontological sites and material is the responsibility of a provincial heritage resources authority (*N.B.* For the Eastern Cape Province this function is carried out by SAHRA).

(2) All palaeontological material is the property of the State. The responsible heritage authority must, on behalf of the State, at its discretion ensure that such objects are lodged with a museum or other public institution that has a collection policy acceptable to the heritage resources authority and may in so doing establish such terms and conditions as it sees fit for the conservation of such objects.

(3) Any person who discovers palaeontological objects or material 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.

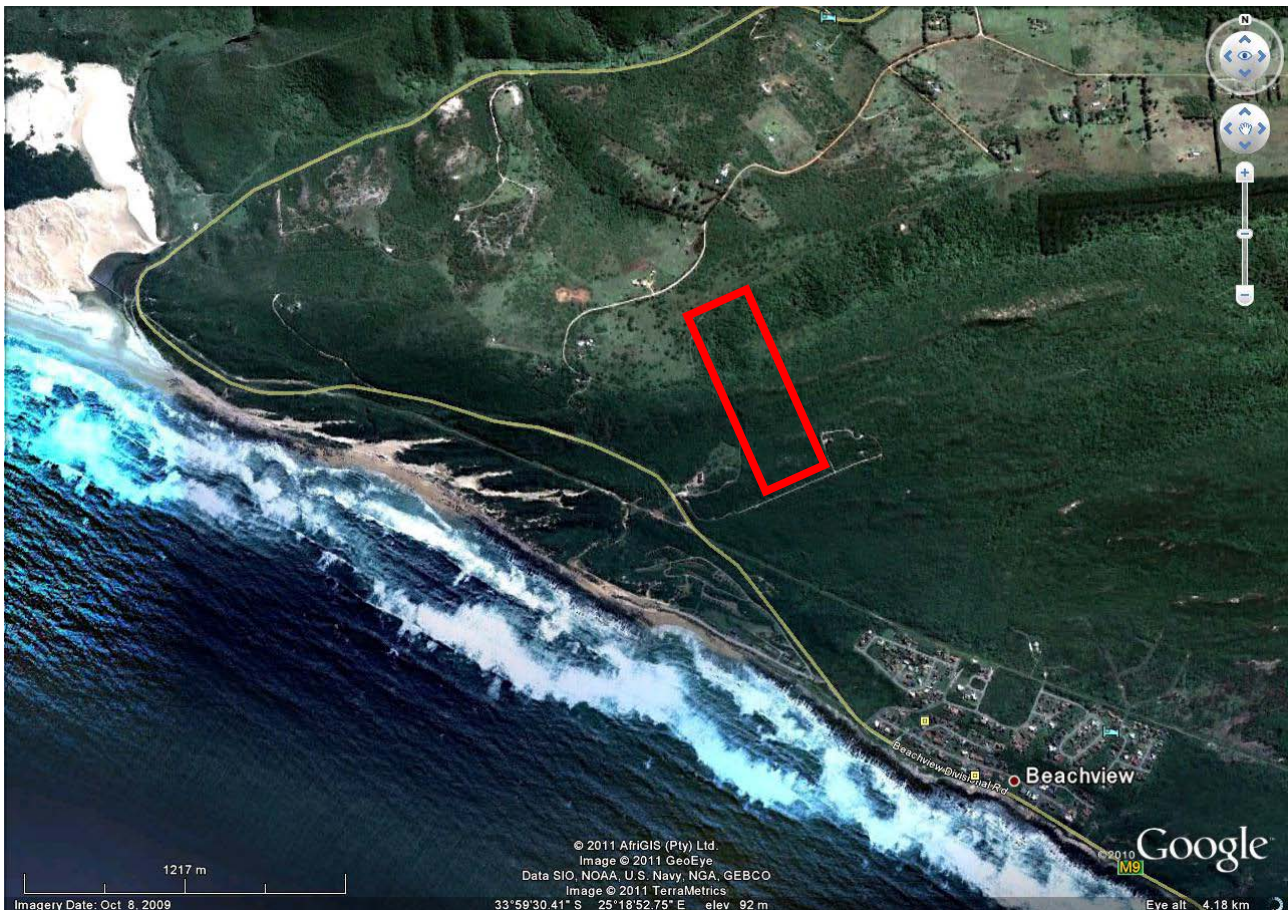
(4) No person may, without a permit issued by the responsible heritage resources authority—  
(a) destroy, damage, excavate, alter, deface or otherwise disturb any palaeontological site;  
(b) destroy, damage, excavate, remove from its original position, collect or own any palaeontological material or object.

## **2.1. General approach used for palaeontological impact desktop studies**

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. 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 preliminary field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond *et al.* 2008). The likely 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 of the development itself, most notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field assessment study by a professional palaeontologist is usually warranted.



Fig. 1. Location of study area (red polygon) on the farm Stades River 485 c. 3km east of Maitland River Mouth, to the west of Port Elizabeth, Eastern Cape Province (Extracted from BID document prepared by CEN IEM Unit, PE).



**Fig. 2.** *Google Earth* satellite image of the area immediately east of Maitland River Mouth showing approximate location of the study area (red rectangle). Note WSW-ENE orientated palaeodune crests and general lack of rock exposure in the area due to dense vegetation cover.

### 3. GEOLOGICAL BACKGROUND

The geology of the study area is indicated on the 1: 250 000 sheet 3324 Port Elizabeth (Council for Geoscience, Pretoria; Toerien & Hill 1989) (Fig. 3 herein). A more detailed 1: 50 000 geological map of the study area is also available, but does not show any additional information as far as the present study area is concerned (Le Roux 2000). The coastal belt here is overlain by unconsolidated Holocene aeolian sands of the **Schelm Hoek Formation (Qw)**. Inland, on the higher ground these give way to the older (Plio-Pleistocene) dune sands of the **Nanaga Formation (T-Qn)**. Both these coastal units belong to the upper part of the Late Cenozoic **Algoa Group** (Le Roux 1990, Maud & Botha 2000, Roberts *et al.*, 2006). Satellite images of the study area show that it is densely vegetated with coastal forest and there is very little or no exposure of bedrock here. The topography appears to be structured by low, WSW-ENE trending aeolian palaeodune crests of the Nanaga Formation.

The coastal aeolianites (ancient or “fossil” dune sands) of the **Nanaga Formation** (Fig 3, **T-Qn**) of Pliocene to Early Pleistocene age crop out extensively to the west of Port Elizabeth (Le Roux 1992). They comprise calcareous sandstones and sandy limestones showing large scale aeolian cross-bedding and may reach thicknesses of 150m or more (Maud & Botha 2000). The Nanaga aeolianites are typically partially to well-consolidated, although unconsolidated sands also occur west of Port Elizabeth (Le Roux 2000). The upper surface of the aeolianites weathers to calcrete and red, clay-rich soil. The age of the palaeodunes decreases towards the modern coastline, reflecting marine regression (relative sea level fall) during the period of deposition. The more highly elevated, inland outcrops may even be Miocene in age (Roberts *et al.*, 2006). Typically the ancient

dunes are preserved as undulating ridges of rounded hills trending parallel to the modern shoreline (Le Roux 1992). These ridges are visible in satellite images of the study area (Fig. 2).

Modern aeolian sands of the **Schelm Hoek Formation** (Algoa Group; **Qw** in Fig. 3; see also Le Roux 1990, fig. 1, Le Roux 2000, Illenberger 1992) are still-active dune sands of Holocene age (last 6500 years). They may be up to 100m thick with an average of 30m, and extend up to 6km from the coast. In addition to unconsolidated, well-sorted, calcareous aeolian sands the Schelm Hoek Formation contains abundant shell middens of the Late Stone Age (Roberts *et al.*, 2006). Palaeosols (ancient soil horizons) and peats are absent according to Le Roux (2000, Table 3) whereas Illenberger (1992) records the presence of fossil soils.

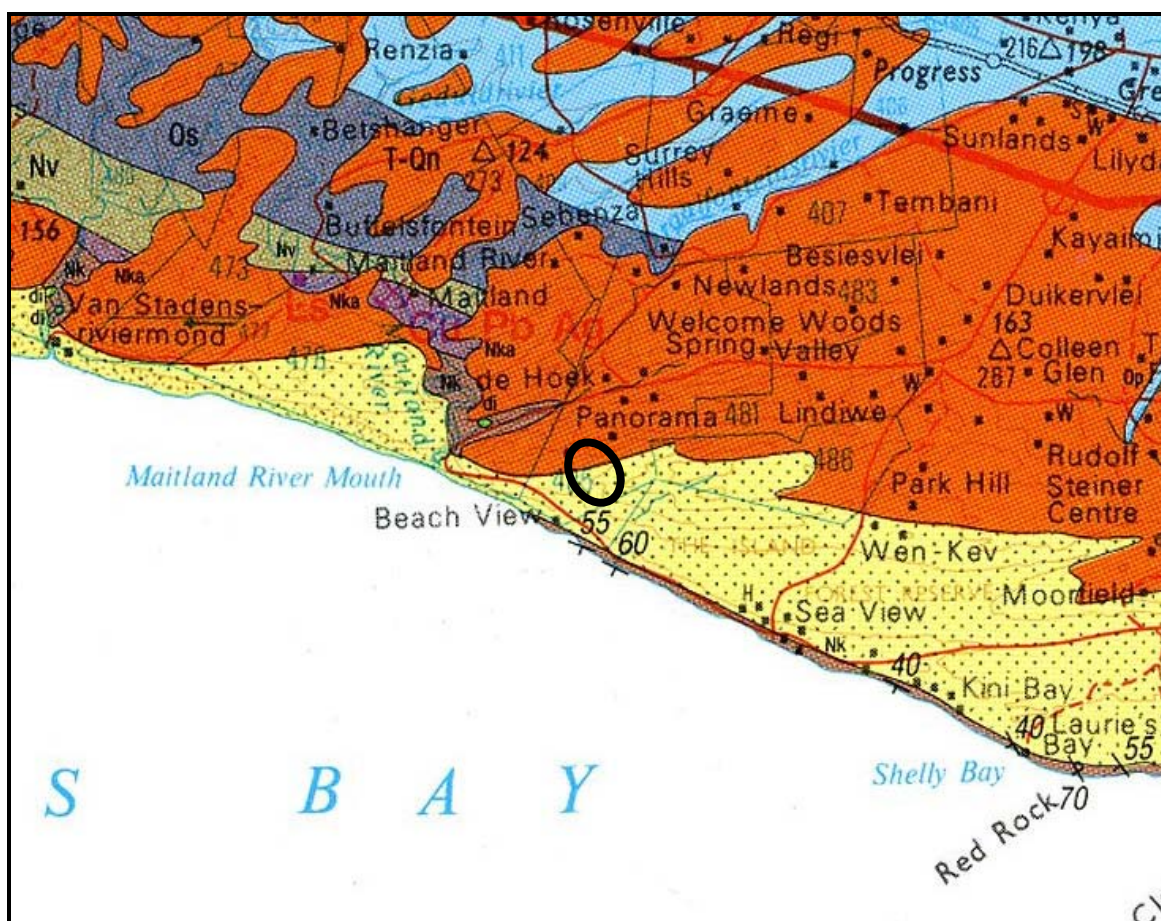
Late Precambrian metamorphosed bedrock of the **Kleinrivier Formation (Nk)** within the **Gamtoos Group** crop out in the study region along the lower course of the Maitlands River as well as all along the coast from Beach View southeastwards towards Red Rock and beyond (Fig. 3; Hill & Nolte 1989, Shone *et al.*, 1990, Gresse *et al.*, 2006). These highly deformed Precambrian metasediments underlie the veneer of Algoa Group sediments on the coastal plain here. The Gamtoos Group rocks are among the oldest mapped in the Eastern Cape Province and typically weather at surface to reddish soils. The Kleinrivier Formation metasediments consist largely of yellowish grey phyllites with subordinate grits, arkoses, quartzites and conglomerates. They show several phases of deformation, intense folding, shearing and thrusting, low-grade metamorphism and a well-developed cleavage. The structure and stratigraphy of the Gamtoos succession as a whole is complex and poorly understood; it may consist of a succession of imbricated thrust slices with concomitant tectonic reduplication (Gaucher & Germs 2006). Postulated depositional settings range from alluvial fans to shallow marine shelf and offshore submarine fans, with the last most applicable to the pelitic Kleinrivier Formation. Quartz-calcite veins in dolomitic limestones of the overlying Kaan Formation were mined for lead, silver, zinc and copper at Maitland Mine along the Maitland River to the northwest of the study area in the 1920s. The deposits were discovered and assayed as early as 1792 and represent one of the earliest mining ventures for metallic ores by Europeans in South Africa (Toerien & Hill 1989 and refs. therein).

#### 4. PALAEOLOGICAL HERITAGE

The sparse palaeontological record of the Pliocene to Early Pleistocene **Nanaga Formation** is summarised by Le Roux (1992) and Almond (2010). The fossil biota consists of fragmentary marine shells, foraminifera (shelled protozoans *cf* McMillan 1990), and a small range of terrestrial snails (*e.g.* *Achatina*, *Tropidophora*, *Trigonephrus*, *Natalina*). Dense arrays of calcretised rhizoliths (root casts) commonly occur in these and contemporary Plio-Pleistocene aeolianites along the southern and southwestern coast (Roberts *et al.*, 2009); spectacular arrays of *megarhizoliths* were recorded from the Nanaga Formation of the Coega area, Eastern Cape by Almond (2010), for example. A wider range of terrestrial fossils might be found here in future, albeit only rarely due to extensive post-depositional diagenesis (*e.g.* solution and reprecipitation of carbonate by groundwater). They might include mammal remains from hyaena lairs, such as are recorded from contemporary Langebaan Formation aeolianites in the SW Cape (Roberts *et al.*, 2006 and refs therein).

The modern coastal aeolianites of the **Schelm Hoek Formation** are generally unfossiliferous to sparsely fossiliferous. However, local concentrations of a wide range of Holocene palaeontological material may occasionally be found here (Engelbrecht *et al.*, 1962, Illenberger 1992, Le Roux 2000, Roberts 2006, Almond 2010. See especially the useful summary by Pether 2008). These include, for example, mammal bones and teeth (*e.g.* in hyaena dens, burrows), tortoise remains, ostrich egg shell, terrestrial snails (*e.g.* the dune snails *Achatina*, *Trigonephrus*), comminuted shell debris (molluscs, echinoid spines, calcareous algae), plant remains (charcoal, rootlets, peats), trace fossils (*e.g.* burrows, mammalian footprints, Stone Age tools), and various groups of microfossils (foraminiferans, pollens, spores). Vertebrate fossils are rare; elephant tusks have been recorded from dunes to the west of Port Elizabeth (Le Roux 2000). In anthropogenic shell middens mollusc taxa such as the edible white mussel *Donax* predominate.

The **Gamtoos Group** is rated as having a low overall palaeontological sensitivity (Almond *et al.*, 2008). Important, albeit low-diversity assemblages of organic-walled marine macrofossils called acritarchs were recently isolated from all constituent “formations” of the Gamtoos succession and indicate a latest Precambrian (late Ediacaran) age for these metasediments (c. 600-542 Ma; Gaucher & Germs 2006). The acritarch assemblages from the Kleinrivier Formation were dominated by simple spherical sphaeromorphs known as leiosphaerids (*Leiosphaeridia minutissima*, *L. tenuissima* and *Chuarina circularis*; *ibid.*, fig. 5). They suggest correlation with the turbiditic Groenefontein and Huisrivier Formations of the Congo Group in the Little Karoo. Macrofossils have not been recorded from the Gamtoos Group, which is hardly surprising given their intensely deformed, metamorphosed condition. There is perhaps potential for stromatolites (laminated microbial reefs) in the carbonate rocks and vendobiontans in the siliciclastic successions. Indeed the latter have recently been discovered in the Groenefontein Formation of the Congo Group (H. Praekelt, pers. comm., 2008).



**Fig. 3. Geological map of an area near Maitland River Mouth to the west of Port Elizabeth. The black ellipse indicates the study area on Farm Stades River No. 478 (Abstracted from the 1: 250 000 sheet 3324 Port Elizabeth, Council for Geoscience, Pretoria). The main geological units relevant to the present study area are: Nk (brown) = Kleinrivier Formation (Gamtoos Group) T-Qn (orange-brown) = Plio-Pleistocene dune sands of the Nanaga Formation (Algoa Group) Qw (pale yellow) = Holocene aeolian sand of the Schelm Hoek Formation**

## 5. CONCLUSIONS & RECOMMENDATIONS

The study area is entirely underlain by sedimentary or metasedimentary rocks that are of low to very low palaeontological sensitivity (Almond *et al.*, 2008). There are therefore no objections to the proposed development on palaeontological grounds, and no further palaeontological mitigation is recommended. However, should substantial fossil remains be exposed during excavations, such as mammalian bones and teeth or dense shell beds, these should be recorded and safeguarded by the ECO responsible, preferably *in situ*. The ECO should also notify SAHRA at the earliest opportunity so that any appropriate mitigation can be implemented, at the developer's expense.

## 6. ACKNOWLEDGEMENTS

Ms Belinda Clark of the CEN Integrated Environmental Management Unit, Port Elizabeth is thanked for commissioning this study and for kindly providing the necessary background information.

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## 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 under the aegis of his Cape Town-based company *Natura Viva cc*. He is 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 APHAP (Association of Professional Heritage Assessment 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 development project, 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.



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