PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

Portion 20 of Farm 397 South Gorah, Kenton-on-Sea, Ndlambe Municipality, Eastern Cape Province, RSA

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1. SUMMARY

The study area is largely underlain by sparsely fossiliferous aeolian sands of the Nanaga Formation (Pleio-Pleistocene). These in turn overlie highly fossiliferous, calcareous marine sediments of the Alexandra Formation (Miocene – Pliocene) and, at depth, potentially-fossiliferous Bokkeveld Group (Devonian) rocks. However, future housing developments on South Gorah are unlikely to involve deep excavations that penetrate through the estimated 20-30m thick veneer of Nanaga Formation aeolianites. Fresh exposures of the underlying richly fossiliferous Alexandria Formation or Bokkeveld Group sediments are not envisaged. The proposed rezoning and subsequent housing developments are therefore not considered to pose a significant threat to local palaeontological heritage.

Nevertheless, any substantial exposures of fresh bedrock created during development should be at least briefly inspected for fossil remains by the responsible Environmental Control Officer. Mammal bones and teeth, peat layers and concentrations (beds, layers or lenses) of well-preserved shells are of particular palaeontological interest. The position of any isolated finds of fossil material found during development should be accurately recorded by the ECO on a 1: 50 000 map / aerial photo or with a GPS. Where practicable, fossil specimens, together with the surrounding rocky matrix, should be carefully collected, labelled, wrapped and handed over to a professional palaeontologist for examination. Should substantial articulated skeletal material, peat layers or coquinas (shell beds or lenses) be discovered, the ECO should inform SAHRA or the Albany Museum, Grahamstown so that they can be inspected, and if necessary sampled, by a professional palaeontologist at the earliest opportunity.

2. INTRODUCTION & BRIEF

The proposed development involves the subdivision and rezoning, from agricultural to residential, of Portion 20 of Farm 397 South Gorah (area *c*. 10.9 ha). Residential dwellings will be constructed on each of the seven subdivisions. The farm is situated on a narrow strip of land between the Boesmans and Kariega Rivers, approximately 7km inland from coast at Kenton-on-Sea, between Alexandria and Port Alfred, Eastern Cape Province (Fig. 1.).

The study area is underlain by potentially fossiliferous marine and aeolian sediments of the Algoa Group (Caenozoic) near-surface and the Bokkeveld Group (Palaeozoic) at depth. A desktop palaeontological impact assessment for the project was therefore requested by SAHRA in accordance with the requirements of the National Heritage Resources Act, 1999. This study was accordingly commissioned on behalf of the client by Craig Weideman, Project Manager at Conservation Support Services, Grahamstown.

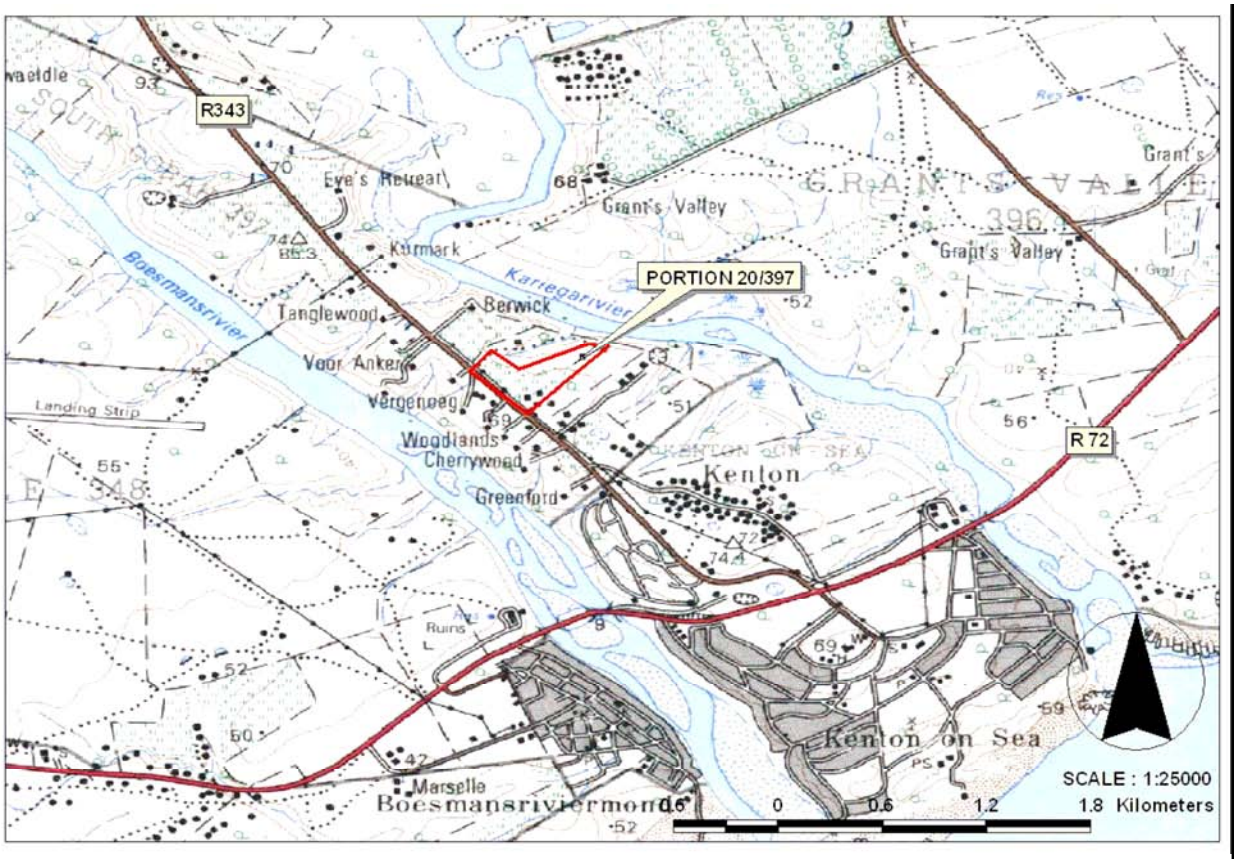

Fig. 1. Location of Portion 20 of Farm 397 South Gora near Kenton-on-Sea, Eastern Cape (Map kindly provided by Conservation Support Services, Grahamstown)

3. GEOLOGICAL BACKGROUND

The geology of the study area is depicted on the published 1: 250 000 scale geological map 3326 Grahamstown (Council for Geoscience, Pretoria, 1995; see also sheet explanation by Johnson & Le Roux 1994). The geology has also been described and mapped in some detail in an undated Interim Geological Report by Mauritz van der Merwe of Port Alfred. According to these sources, Portion 20 of South Gorah farm is underlain at surface by some 20-30m of ancient dune sands of the **Nanaga Formation** (T-Q, Algoa Group, Pliocene – Pleistocene) with *c*. 5m of calcareous sandstones and conglomerates of the coastal marine **Alexandria Formation** (Ta, Algoa Group, Miocene-Pliocene) at its base. The Algoa Group sediments rest in turn on a marine-planed platform incised into much older marine to ?coastal / deltaic sediments of the **Bokkeveld Group** (Db). The contact between the basal conglomerate of the Alexandria Formation and the Bokkeveld Group skirts the northern margin of Portion 20 (Map in Fig. 2 of Van der Merwe) which is

therefore entirely covered with a veneer of Algoa Group sediments and their derivative soils.

Satellite, aerial and ground images of the study area provided by Conservation Support Services as well as the Phase 1 HIA by Binneman and Booth (2008) and the geological report by Van der Merwe indicate that there are no substantial exposures of fresh (unweathered) Algoa or Bokkeveld bedrock in the study area. Algoa and Bokkeveld Group sediments are soil- or vegetation-covered and are likely to be deeply weathered themselves, seriously compromising their palaeontological potential.

4. PALAEONTOLOGICAL HERITAGE

A brief review, with selected references, of the palaeontological heritage recorded within the various stratigraphic units present at South Gorah is given here.

4.1. Bokkeveld Group (Early to Mid Devonian). Overall palaeontological sensitivity: HIGH

Due to poor exposure, structural complexity (folding) and deep weathering, the Bokkeveld Group is not subdivided into constituent formations on the 1: 250 000 geological map of the Grahamstown area. It is not possible to state with any certainty if the Bokkeveld sediments in the study area belong to the Lower or Upper Bokkeveld Group, though the latter is perhaps somewhat more likely given their proximity to Witteberg Group rocks less than 5km to the north. Johnson and Le Roux (1994) suggest that most of the Bokkeveld rocks in the Grahamstown area belong to the "unfossiliferous Traka Subgroup" (*ibid*., p6). Given the stratigraphic uncertainties, a brief review of the known fossil record of the entire Bokkeveld Group, based largely on better-known, less deformed western outcrop area, is provided here.

The most important fossil groups recorded from the **Lower Bokkeveld Group** (**Ceres Subgroup**) include shelly marine invertebrates and traces (burrows *etc*), together with rare fish remains, primitive vascular plants, trace fossils (burrows, borings *etc*) and microfossils (*eg* foraminiferans, ostracods, palynomorphs). The overall palaeontological sensitivity of this stratigraphic unit is generally considered to be *high to very high* (Almond *et al*. 2008).

The Lower Bokkeveld Group is especially well known for its rich fossil assemblages of marine invertebrates of Early to Mid Devonian age. The main invertebrate taxa concerned are trilobites, brachiopods, molluscs and echinoderms. Numerous more minor groups are also recorded - corals, conulariids, hyolithids, tentaculitids *etc* - making the Bokkeveld Group one of the palaeontologically most important Devonian units in the southern hemisphere. Fossil invertebrates are especially diverse and abundant within the mudrock-dominated formations, although low-diversity sandstone-hosted fossils assemblages also occur. Shells are generally preserved as external and internal moulds and casts (*eg* Schwarz 1906, Reed 1925, Du Toit 1954, Cooper 1982, Oosthuizen 1984, Hiller 1995, Hiller & Theron 1988, Theron & Johnson 1991, Jell & Theron 1999, Thamm & Johnson 2006, Almond 2008). Remarkably rich marine trace fossil assemblages are also known from the lower Bokkeveld Group, especially in nearshore facies (Almond 1998).

The only vascular plants recorded from the Ceres Subgroup are a small range of dichotomously branching, leafless forms known as psilophytes (*eg Dutoitia*) and primitive lycopods or "club mosses" such as *Palaeostigma*. The material is generally transported

(washed offshore from the land), poorly preserved, and has mainly been recorded from the eastern outcrop area of the Bokkeveld Group (Plumstead 1967, 1969, Theron 1972, Anderson and Anderson 1985).

Very sparse fossil fish remains have been recorded from the Ceres Subgroup (Gydo and Tra Tra Formations), several retaining their original phosphatic bony material. They comprise acanthodians ("spiny sharks"), primitive sharks, placoderms, and bony fish or osteichthyans, but so far no agnathans (Almond 1997, Anderson *et al*. 1999a, 1999b). The material is fragmentary but of considerable palaeontological significance since so little is known about Early Devonian ichthyofaunas of the ancient supercontinent Gondwana.

So far, the great majority of published records of fossils from the Ceres Group refer to the much better known western outcrop areas in the Western Cape. In the Eastern Cape Province, where the potentially fossiliferous mudrocks are frequently highly deformed, cleaved, and often deeply weathered or covered by dense vegetation, the fossil known record is still rather sparse and understudied. Most of the early geological mapping surveys revealed very few useful fossil records – essentially a scattering of poorly preserved, often deformed marine shells and locally abundant trace fossils (*eg* Haughton 1928, 1935, Haughton *et al*., 1937, Engelbrecht *et al*., 1962, Mountain 1946, 1962, Johnson & Le Roux 1994).

Within the western part of the Eastern Cape Province, only a handful of productive fossil localities within the Ceres Subgroup have been recorded so far. Most notably, these include the Cockscomb area between Willowmore and Steytlerville, Klein Kaba near Alexandria, and the Uitenhage North area (*eg* Haughton 1928, Mountain 1946, Theron 1972, Johnson 1976, Hiller 1980, Oosthuizen 1984, Toerien & Hill 1989, Le Roux 2000). As is the case to the west, shelly fossils are most abundant in the mudrock-dominated formations, including the Gydo, Voorstehoek and Tra Tra Formations. Indeed, the Voorstehoek Formation in the Eastern Cape may prove quite productive, although the assignation of some faunal records to this unit requires confirmation (*eg* Hiller 1980, Oosthuizen 1984, Hiller 1990). Useful faunal lists for the rich Gydo Formation biota at the Cockscomb Mountains and the ?Voorstehoek Formation biota at Klein Kaba are given by Oosthuizen (1984, Table III and p.138 respectively). The Cockscomb biota is preserved as moulds within early diagenetic nodules of phosphatic or other composition (*cf* Browning 2008). It includes a wide range of trilobites, brachiopods, bivalves, gastropods, crinoids, a possible echinoid, corals, abundant well-preserved conulariids, ostracods and various problematic groups (*eg* hyolithids, tentaculitids and other tubular fossils). The Klein Kaba faunule listed by Oosthuizen (1984) is dominated by a number of articulate brachiopods, but also comprises gastropods, bivalves, nautiloids, trilobites, crinoids, conulariids, various tubular fossils and traces. Possible Gamka Formation sandstones cropping out at the coast at Cannon Rocks (*c*. 15km SW of Kenton-on-Sea) contain moulds of brachiopods and crinoids (Johnson & Le Roux 1994).

Very little reliable information is available concerning the fossil record of the **Upper Bokkeveld Group** (**Traka Subgroup**) of this region, which has been relatively little studied (Theron 1972, Johnson 1976, Johnson & Le Roux 1994). These sediments have been ascribed to offshore shelf to deltaic depositional settings. Johnson (1976) records that the "Traka Group is generally unfossiliferous except in the extreme west", whereas in the eastern outcrop area the sediments are usually highly deformed, with extensive development of slaty cleavage in the mudrock units, exacerbating the recognition and collection of fossil material. In general, shelly marine fossils appear to be rare, in contrast to the Ceres Subgroup of the Western Cape. Trace fossils, including *Spirophyton*, are

locally abundant and vascular plant axes (mainly lycopods) may be common within sandier units, for example near Alexandria. Apart from probable records of the primitive vascular plant *Dutoitea*, most early records of plant material and arthropods from the Bokkeveld Group in the Eastern Cape, such as those from near Port Alfred, are probably more correctly assigned to the lower Witteberg Group (Anderson & Anderson 1985, *cf* earlier accounts by Schwarz 1906, Seward 1932, Mountain 1946, 1962 pp5-6, who originally assigned these biotas to the Bokkeveld Group). By comparison with the better known, less deformed western outcrop area of the upper Bokkeveld Group it is likely that a variety of freshwater to estuarine fish groups (placoderms, acanthodians, primitive sharks *etc*) as well as non-marine bivalves are present in Traka Group sediments but have yet to be discovered (*eg* Chaloner *et al*., 1980, Almond 1997, Anderson *et al*. 1999a, 1999b).

4.2. Algoa Group (Late Caenozoic)

The stratigraphy, palaeontology and sedimentology of Late Caenozoic coastal sediments of the Algoa Group along the south-eastern coast of South Africa have been reviewed by Le Roux (1986, 1987a,b, 1989a, 1990a, b. 1993, 2000), Maud and Botha (2000), as well as most recently by Roberts *et al*. (2006).

4.2.1. Alexandria Formation (Algoa Group, Miocene – Pliocene)
Overall palaeontological sensitivity: HIGH

This estuarine to coastal marine formation consists of a basal conglomerate rich in oyster shells overlain by calcareous sandstones, shelly coquinas and thin conglomerates. It is a composite product of several marine transgression / regression cycles across the south coastal plain in Late Miocene-Pliocene times, *ie* roughly around 7-5 Ma ago (Maud & Botha 2000, Roberts *et al.* 2006). The unit is typically highly fossiliferous but good vertical exposures in the interior are usually limited by cover of younger sediments of the Algoa Group (*eg* Nanaga Formation aeolianites) or weathered surface material of the so-called "Bluewater Bay" facies. A wide range of marine fossils – mainly molluscs (bivalves, gastropods), but also sea urchins (the "sea pansy" *Echinodiscus*), corals, bryozoans, brachiopods, sharks' teeth, other fish teeth and coprolites, benthic foraminifera and trace fossils (*eg* pellet-walled burrows of *Ophiomorpha*) – have been recorded from the Alexandria Formation since the early twentieth century (*eg* Newton 1913, Du Toit 1954, Barnard 1962, Engelbrecht *et al*. 1962, Mountain 1962, King 1973, Dingle *et al*., 1983, Le Roux 1987a,b, 1990b, 1993, McMillan 1990, Johnson & Le Roux 1994). Robert Gess (undated heritage report for the Coega development, E. Cape) also mentions mammal bones found in this unit. It is highly likely that any new excavations intersecting the Alexandria Formation during development will prove fossil-rich and sampling of these by a professional palaeontologist would be of scientific value.

4.2.2. Nanaga Formation (Pliocene / Early Pleistocene)
Overall palaeontological sensitivity: LOW

Well- to partially-consolidated Pliocene to Early Pleistocene aeolianites (dune sands) of the Nanaga Formation occur extensively on the coastal plain of the Alexandria – Port Alfred region where their preservation has been promoted by Pliocene uplift. This unit underlies much of the study area. The sparse palaeontology of the Nanaga Formation is summarised by Le Roux (1992; see also Johnson & Le Roux 1994). The fossil biota consists of fragmentary marine shells, locally abundant foraminifera (*cf* McMillan 1990),

plant rootlet horizons, and a small range of terrestrial snails (*eg Achatina, Tropidophora, Trigonephrus, Natalina*). A limited variety of other terrestrial fossils, such as rare vertebrate bones, teeth (perhaps associated with hyaena dens) and even trackways, as well as organic-rich peats or mudrocks might be encountered subsurface within these aeolianites, especially along palaeosol horizons, and are of palaeontological interest.

5. CONCLUSIONS & RECOMMENDATIONS

Future housing developments on South Gorah are unlikely to involve excavations that penetrate through the estimated 20-30m thick veneer of Nanaga Formation aeolianites that are generally only sparsely fossilferous and therefore of low palaeontological sensitivity. Fresh exposures of the underlying richly fossiliferous Alexandria Formation or Bokkeveld Group sediments are therefore not envisaged. The proposed rezoning and subsequent housing developments are therefore not considered to pose a significant threat to local palaeontological heritage.

Nevertheless, any substantial exposures of fresh bedrock created during development should be at least briefly inspected for fossil remains by the Environmental Control Officer. Mammal bones and teeth, peat layers and concentrations (beds, layers or lenses) of well-preserved shells are of particular palaeontological interest.

Should isolated fossils be encountered during excavations, they should be carefully collected, with adherent matrix where necessary, given a provisional reference number (*e.g.* marked on masking tape) and carefully wrapped in newspaper. It is *essential* that the locality where the fossil is found be accurately marked on a 1: 50 000 map or recorded by GPS. Specimens without locality information are of limited scientific value. In the case of fossils within the surface sandy sediments of the Algoa Group, it is also important to record the nature of the matrix (*eg* cemented / uncemented sandstone) and the depth below surface. The fossils should be submitted for inspection by a professional palaeontologist at the earliest opportunity. Some of this material may be of scientific interest - in which case it should be deposited ultimately in an approved repository (*e.g.* Albany Museum, Grahamstown or East London Museum) – while other specimens may be of educational value and might be donated for display purposes.

If well-articulated skeletons, peat layers or shell-rich beds / lenses are encountered during construction, they should *NOT* be informally excavated since this will almost invariably lead to damage and loss of useful contextual information (*e.g.* taphonomy – data on mode of death and burial of animals). If feasible, skeletal remains or shell beds should be photographed (with scale), covered with a protective layer of loose sediment, and the site marked and carefully recorded (GPS / 1: 50 000 map / aerial photograph). The Environmental Control Officer should immediately inform SAHRA or the responsible palaeontologist at the Albany Museum (Dr Billy de Klerk, 046-622 2312; b.deklerk@ru.ac.za) so that specimens can be examined and, if necessary, professionally excavated.

6. ACKNOWLEDGEMENTS

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