1 PALEONTOLOGICAL SPECIALIST REPORT

Prepared for:	**On behalf of:**	**Prepared by:**
Coastal & Environmental Services	**Exxaro Resources Limited**	**Natura Viva cc**
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DECLARATION OF INDEPENDENCE	
Palaeontological Assessment	I **Dr John Almond** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Exxaro AlloyStream™ Manganese 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. **SIGNATURE:** 

1.1 Introduction

2.1.1. Background

Coastal and Environmental Services (CES) in Grahamstown on behalf of Exxaro Resources Limited requested that Natura Viva cc conduct a desktop Palaeontological Assessment for the proposed construction of the Exxaro AlloyStream™ Manganese Plant to be located within the Coega Industrial Development Zone (IDZ) situated approximately 25kms from Port Elizabeth in the Eastern Cape Province of South Africa.

Two, approximately 15 ha alternative sites (Option 1 and Option 2) are proposed for construction of the Exxaro AlloyStream™ Manganese Plant within Zone 6 – the zone designated for heavy ferrous metal industries of the Coega IDZ. Although each site is 15 hectares in area, it is initially envisaged to utilise only four hectares.

As indicated in the Draft Scoping Report (CES, 2008) the proposed project is likely to include a number of ancillary developments in addition to the main furnace. These constructions will also involve bedrock excavation, and may therefore affect local palaeontological heritage. They include, among others:

- railway, truck or container offloading area
- bunkers for incoming materials
- slag storage area
- water cooling plants
- storm water containment dam

Most of these developments will entail bedrock excavations of no more than 2m, while excavations for the furnace foundations will not exceed 20m.

The Coega IDZ overlies highly fossiliferous sediments of Cretaceous to Neogene (late Tertiary) age within the Algoa Basin. Several of these fossil-bearing geological units are likely to be directly affected by the proposed development through the excavation of and / or permanent sealing-in of fossiliferous bedrock.

Palaeontological heritage in South Africa is protected by the National Heritage Resources Act 25 of 1999 which requires that any development or other activity which will change the character of a site exceeding 5 000m², or the rezoning or change of land use of a site exceeding 10 000 m², requires a heritage impact assessment. The extent of the proposed development (about 15 ha) therefore falls within the requirements for an heritage impact assessment, as required by Section 38 of the National Heritage Resources Act 25 of 1999. The aim of this specialist study was to determine, based on relevant literature, the likelihood of occurrence of palaeontological remains that may be negatively impacted by the planning, construction and implementation of the proposed project, to assess the significance of the potential impacts and to propose measures to mitigate against these impacts.

In addition to this desktop Palaeontological Impact Assessment (PIA), a separate Phase 1 archaeological assessment has been conducted by archaeologist Jonathan Kaplan on the two sites proposed for the Exxaro AlloyStream™ Manganese project (see Chapter 1 above) and will compliment this palaeontological report.

2.1.2. Terms of Reference

Specialists were required to address issues raised by I&APs (see Appendix A) in their reports. The palaeontological assessment was limited to a desk top study, and the terms of reference for this specialist study were:

- Determination of the likelihood of palaeontological remains of significance on the proposed alternative sites (Options 1 and 2) within the Coega IDZ;
- Assessment of the likely sensitivity and significance of palaeontological remains on the site;
- Suggest measures to mitigate any negative impacts to palaeontological remains during the construction and operational phases of the proposed project;
- Provide an indication of which, if any, of the two alternative sites (Option 1 or Option 2) is preferred from a palaeontological perspective, and;
- Preparation of a written report on the above.

1.2 Outline of the Geological Context

The Coega IDZ, situated some 25km north-north-east (NNE) of Port Elizabeth (Eastern Cape Province) lies just inland of Algoa Bay within a south-central portion of the Cretaceous Algoa Basin known as the Sundays River Trough (1: 250 000 geology sheet 3324 Port Elizabeth, Council for Geoscience, Pretoria; Toerien & Hill 1989; see also more detailed 1: 50 000 geology sheets 325 DC & DD, 3425 BA Port Elizabeth, 3325 DA Addo; Le Roux, 2000). This trough is a downfaulted depression to the southwest of the WNW-ESE Colchester Fault that contains a thick succession of Early Cretaceous terrestrial to marine shelf sediments of the **Uitenhage Group** (**Kirkwood** and **Sundays River Formations**; see geological sections and maps in McMillan, 2003 and refs. therein). These older fossiliferous sediments are truncated by a major erosional hiatus that is overlain by a thin, but palaeontologically significant, veneer of Neogene (Miocene-Pliocene) shallow marine, coastal and estuarine sediments of the **Algoa Group** (**Alexandria Formation**) (Le Roux 1990a, 2000, Maud & Botha 2000, Roberts *et al*. 2006). Geologically recent karstic (*ie* solution) weathering of the lime-rich Alexandria Formation has led to the development of an extensive pebbly, reddish-brown surface deposit over much of the inland outcrop area of the formation (Maud & Botha 2000). This was formerly identified as a separate, bipartite fluvial unit of Plio-Pleistocene age with calcrete horizons called the **Bluewater Bay Formation** (Le Roux 1987c, 1989) and is mapped as such on the 1: 250 000 Port Elizabeth geology sheet. Incised channels cutting into the Alexandria Formation and infilled with cross-bedded coarse “Bluewater Bay” gravels are illustrated by Le Roux (1989). They suggest that these contested surface deposits may well comprise a composite of *in situ* karstic weathering products (including coarse solution-hollow infills) as well as fluvial sediments of late Neogene age. On the recent 1: 50 000 geology maps listed above, these deposits are indicated as “pedogenic gravels (weathered Alexandria Formation)” (See also Le Roux 2000, p.37).

The superficial “Bluewater Bay” deposits average 1.2m in thickness, but this varies greatly due to the presence of occasional incised channel-fill and solution pipe structures up to 7m deep (Le Roux 1987c, 1989, 2000). The Alexandria Bay Formation ranges

from 3 to 13m in thickness, with an average of 9m (Le Roux 1987b, 2000). Maud & Botha (2000) record a maximum thickness of 18m, while Robert Gess (undated heritage report) reports an average thickness of 7m for the Alexandria Formation in the Coega region. The majority of excavations for the proposed Exxaro AlloyStream™ Manganese Project site at Coega (*eg* for foundations) will be less than 2m deep and are therefore unlikely to intersect the underlying Sundays River Formation sediments. However, this possibility cannot be entirely excluded on the basis of the very limited subsurface geological information available, while foundations for the furnace may reach a maximum depth of 20m. As a result, the potential impact of developments within the Coega IDZ on palaeontological heritage within the Early Cretaceous Sundays River Formation have also been briefly considered in this report. The still older Kirkwood Formation crops out along the banks of the Coega River just to the west of the study area, but this unit is too deeply buried beneath the surface within Zone 6 of the Coega IDZ to be affected by developments there.

Recent independent archaeological heritage scoping studies undertaken within Zone 6 of the Coega IDZ by Dr Lita Webley of the Albany Museum (unpublished report, 2007) and Jonathan Kaplan of the Agency for Cultural Resource Management (pers. comm., August 2008) revealed a surface cover of recent sands or soil underlain by a layer of quartzite cobbles above an irregular calcrete surface, with some surface exposure of calcrete. Mollusc shells (probably freshwater unionids) embedded within surface calcrete lumps were also observed. A photo of a vertical trench section some few metres deep provided by Mr Kaplan appears to show dark soil overlying a thin layer of poorly-consolidated, calcretised surface material (Bluewater Bay Formation?) which is underlain by more consolidated, well-bedded pale sediments. These last may be calcareous beds of the Alexandria Formation, or alternatively (Webley, 2007) thick subsurface calcretes. Near-surface calcretes (*ie* pedogenic limestones) are typically developed above lime-rich sediments of the Alexandria and Sundays River Formations (Le Roux 2000, p. 38).

1.3 Summary of Palaeontological Heritage

Sections 9.3.1 – 9.3.3 below provide an outline of the palaeontological heritage recorded from each of the three near-surface geological units represented at Zone 6 of the Coega IDZ. An estimate of the overall palaeontological sensitivity of each unit following the ongoing review of the palaeontological heritage of the Eastern Cape by Almond *et al*. (2008) is also provided.

It is important to note that both alternative sites (Option 1 and Option 2) within Zone 6 of the Coega IDZ that are under consideration for the proposed Exxaro Alloystream™ Manganese Project are underlain by the same geological units, and their palaeontological sensitivity is therefore identical. Consequently neither site is preferred over the other based on palaeontological heritage grounds.

2.3.1. Early Cretaceous Sundays River Formation

(Overall palaeontological sensitivity: HIGH)

The Sundays River Formation is of Early Cretaceous (Valanginian-Hauterivian) age, *ie* between 130-140 Ma (million years old). It comprises a thick (up to 2km) succession of

grey sandstones, siltstones and finer mudrocks that are often highly fossiliferous (Le Roux 2000, Shone 2006). Depositional settings range from estuarine through littoral to outer shelf (McMillan 2003). In palaeontological terms it contains one of the most prolific and scientifically important marine biotas of Mesozoic age in southern Africa.

Fossils have been recorded from these beds in the Algoa Basin since the early nineteenth century (1837) and there has been a long history of palaeontological publications dealing with the Sundays River fauna since then (see especially Cooper 1981 for early literature). Among the key papers and reviews are those by Sharpe (1856), Kitchin (1908), Spath (1930), Du Toit (1954), Engelbrecht *et al*. (1962), Haughton (1969), McLachlan & McMillan (1976, 1979), Klinger & Kennedy (1979), Cooper (1981, 1991), Dingle *et al*. (1983), McMillan (2003) and Shone (2006). An accessible, well-illustrated account of Sundays River fossils has recently been given by MacRae (1999).

The main invertebrate fossil groups recorded from the Sundays River Formation include a rich variety of molluscs (ammonites, nautiloids, belemnites, gastropods and many genera of bivalves), corals, serpulid polychaetes, echinoids, and crustaceans. There are also plant remains (*eg* bored wood, amber, plant debris), rare vertebrates (*eg* marine plesiosaur reptiles and isolated dinosaur bones and teeth), diverse and abundant trace fossils, and a wide spectrum of microfossils, notably foraminiferans, ostracods, dinoflagellates and land-derived pollens and spores. Among all these the ammonites and microfossils are of particular biostratigraphic importance, while the foraminiferans are useful for palaeoenvironmental analysis (See extensive discussion in McMillan 2003).

Despite the long history of palaeontological work on Sundays River fossils, there has been little systematic collection of fossils – especially macrofossils - from these beds in recent decades and most taxa remain poorly studied (*eg* most invertebrate groups, apart from the ammonites and trigonid bivalves). The Coega area – notably the Coega Brick Pits just west of the Coega IDZ – has been sampled extensively over the years for micro- and macrofossil remains, though much work remains to be done even here and a lot of palaeontologically interesting material is being destroyed through neglect. Any deeper excavations made during development within the Coega IDZ that intersect the Sundays River beds should therefore be systematically sampled for fossil remains by a qualified palaeontologist.

2.3.2. Miocene – Pliocene Alexandria Formation

(Overall palaeontological sensitivity: HIGH)

This estuarine to coastal marine formation, consisting of a basal “conglomerate” rich in oyster shells overlain by calcareous sandstones, shelly coquinas and thin conglomerates, 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, Le Roux 2000, Roberts *et al.* 2006). It overlies a series of marine terraces incised into older (mainly Cretaceous) rocks in the hinterland of the Algoa Basin (Ruddock 1968). The unit is 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 “Bluewater Bay” facies.

A wide range of marine fossils – mainly molluscs (over 170 species, mainly bivalves and gastropods), but also sea urchins (*eg* the “sea pansy” *Echinodiscus*), corals, bryozoans, brachiopods, crustaceans, the teeth, vertebrae and coprolites of sharks and other fish, 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, King 1973, Dingle *et al*., 1983, Smuts 1987, Le Roux 1987a,b, 1990b, 1993, 2000, McMillan 1990). Locally, a basal coquina or “conglomerate” largely composed of oyster shells is developed, and shell-rich coquinas

also occur higher within this unit. Bones and teeth of terrestrial mammals such as bovids and suids have also been recently recorded here (Le Roux 2000). One of the reference stratotype sections for the Alexandria Formation (Stratotype D of Le Roux 1987b, pp. 11-13) is situated at near Coega, northeast of the Coega River and close to the study area. Here, the unit is some 7-8m thick and richly fossiliferous. It is highly likely that new excavations intersecting the Alexandria Formation made during this development will also prove fossil-rich and sampling by a professional palaeontologist would be of scientific value, especially given the limited surface outcrop of this unit in the interior of the Algoa Basin.

2.3.3. Pliocene – Pleistocene "Bluewater Bay Formation"

(Overall palaeontological sensitivity: LOW)

The contested geological origins of this - probably composite, pedogenic – superficial unit have been emphasised in Section 9.2 above. In any case, a late Neogene (Plio-Pleistocene) age is likely, *ie* < 5 Ma, and it is probably much younger (Le Roux 1987c, 1989). In contrast to the relatively unweathered Alexandria Formation beneath, the Bluewater Bay unit is characterised by the absence of fossil marine shells. Depending on the geological origins of the deposits, this may variously reflect the extensive dissolution of derived calcareous shelly material during karstic weathering of the fossiliferous (Alexandria Formation) parent rock and / or a fluvial (and often high-energy) setting (See also discussion in Le Roux 2000, p. 37). Stratotype sections for this unit were established by Le Roux (1989) at Bluewater Bay and the Swartkop Salt Pan some 15-20km SW and WNW of the Coega IDZ respectively.

Le Roux (1989) records the presence of occasional freshwater molluscs (*eg* unionids) and fragmentary "terrestrial shells", presumably land snails (*eg Achatina*; *cf* Le Roux 1987b, p. 13). As with any such superficial terrestrial deposits of late Neogene age, especially in areas or horizons where calcareous layers (*eg* calcretes) abound, a wide range of other fossil animal and plant material might be encountered here. This may include: carapaces and bones of tortoises, ostrich egg shells, insect traces (*eg* calcretised termitaria), bones and teeth of small to large mammals (moles, bovids, elephant *etc*) as well as calcretised root casts (rhizoliths, rhizocretions). Scoping of new exposures and sections through these deposits for palaeontological remains during development is therefore also recommended.

1.4 Significance Statement

The CES impact rating scale was used to assess the potential impact of the proposed Exxaro AlloyStream^{TM} Manganese Project on palaeontological heritage at the site(s) and beyond (Table 2-1).

Please note that the *positive* values used for impacts following mitigation in Table 2-1are intended to show that this mitigation should convey positive benefits for palaeontological heritage, both locally and nationally. In contrast, failure to mitigate would entail the permanent loss of potentially rich palaeontological heritage destroyed by excavations or "sealed in" below the proposed development site.

Table 2-1: The potential impact of the proposed Exxaro AlloyStream™ Manganese Project on palaeontological heritage at the site(s) and beyond.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1 AND OPTION 2 SITES										
Without Mitigation	Permanent	-4	Study area	-2	Severe	-4	Definite	-4	**-14 (Detrimental)**	**HIGH NEGATIVE IMPACT**
With Mitigation	Long Term	+3	National	+3	Beneficial	+2	Probable	+3	**+11 (Beneficial)**	**MODERATE POSITIVE IMPACT**

1.5 Cause and Comment

Excavations made during construction of the proposed Exxaro AlloyStream™ Manganese Plant and associated ancillary structures will expose and modify potentially fossiliferous sediments that are currently buried beneath the land surface. Study and sampling of these sediments and their enclosed fossils by a qualified palaeontologist while they are still exposed is necessary, before they are permanently sealed in by further development and thereby lost to science. If appropriate mitigation is carried out, as outlined below, this will usefully contribute to our understanding of the rich palaeontological heritage of the Coega region.

Essential palaeontological heritage mitigation for this project should involve:

- The appointment of a qualified palaeontologist ***before*** the commencement of excavations to undertake specialist mitigation work for this project. Before mitigation work begins, the palaeontologist involved will need to obtain a fossil collection permit from the South African Heritage Resources Agency (SAHRA) and make arrangements with an approved repository (*eg* museum, university) to store and curate any fossil material collected.
- Development of a provisional schedule and protocol for field inspection, study and sampling of exposed fossiliferous sediments by the appointed palaeontologist, in advance of construction and in collaboration with managers responsible for construction. The frequency and extent of palaeontological inspection and sampling undertaken will necessarily depend on the richness and scientific importance of any fossils revealed during excavation, which is not predictable in detail. Therefore, the provisional mitigation schedule may well need to be modified accordingly as development proceeds. If important fossil deposits are encountered, intermittent mitigation is likely to be necessary as long as excavations are accessible.
- Basic training of the responsible Environmental Control Officer (ECO) regarding the nature of fossil heritage that may be affected by the proposed development (*eg* major fossil groups concerned) and the establishment of an agreed protocol for the protection and handling of fossil materials exposed while the palaeontologist is not on site.

1.6 Conclusions and Recommendations

The overall palaeontological sensitivity of the Coega IDZ as a whole is high to very high, since it is underlain near-surface by two of the most richly fossiliferous marine formations in the South African rock succession, viz. the Early Cretaceous Sundays River Formation (Uitenhage Group) and the Miocene-Pliocene Alexandria Formation (Algoa Group). Some, perhaps even most, excavations for the proposed Exxaro AlloyStream™ Manganese Plant that are much over one meter deep may well encounter fossiliferous sediments of the Algoa Group. Only deeper excavations (>9m), such as those for the furnace foundations, are likely to intersect the underlying Cretaceous beds of the Sundays River Formation. Pedogenic surface deposits previously assigned to the "Bluewater Bay Formation" are of limited palaeontological interest, but they should also be inspected for possible fossil material such as vertebrate bones, teeth and non-marine molluscs.

It is therefore essential that adequate opportunity to record and sample fossil biotas from new subsurface rock exposures within the site chosen for the proposed Exxaro Alloystream™ Manganese Plant is afforded to a professional palaeontologist during the course of excavations and before these sediments are permanently "sealed in" by development. This work should involve detailed recording of sedimentary facies, fossil distribution and other palaeontologically relevant information as well as fossil collection. The palaeontologist involved will be required to obtain a palaeontological mitigation permit from SAHRA in advance. This will also involve designating an approved depository for fossil material collected during the course of the study.

A comprehensive and realistic palaeontological monitoring programme should be negotiated between Exxaro Resources Limited and the professional palaeontologist concerned before development (and especially deep excavation) commences. As part of this monitoring programme, the responsible ECO should receive instruction from a palaeontologist concerning the nature and types of fossils likely to be encountered, and the protocol to be followed should fossils be encountered while the palaeontologist is not on site.

It should be emphasised that, provided adequate palaeontological mitigation is guaranteed and undertaken, developments in the Coega IDZ are likely to make a positive contribution to our understanding of fossil heritage within the fossil-rich Algoa Basin.

Given the scale and scientific value of the fossil collections that may well be acquired through palaeontological mitigation at the Coega IDZ over the coming years, it would be appropriate for an informative, educational display to be set up either at Coega itself and/or a nearby educational institution such as the Albany Museum, Grahamstown or the Port Elizabeth Museum.