Heritage Western Cape RoD ....

PALAEONTOLOGICAL IMPACT ASSESSMENT

(Desktop Study)

PROPOSED WIND ENERGY FACILITY

Koingnaas Wind Energy Facility (Proposed by Just Palm Tree Power)

By

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22 September 2011

SUMMARY

This assessment (PIA) has been prepared at the request of Savannah Environmental (Pty) Ltd. It is the part of the Heritage Impact Assessments in the EIA processes being undertaken by Savannah Environmental for Just Palm Tree Power who propose to establish a wind energy facility (WEF) for generation of electricity on an area on the Namaqualand coast, Northern Cape (Figure 1).

» Koingnaas Wind Energy Facility is proposed by Just Palm Tree Power (Pty) Ltd.. It is a much smaller WEF involving up to 24 small turbines generating less than 10 MW.

The main purposes of this report are to:

» Outline the nature of possible palaeontological heritage resources in the subsurface of the affected areas.

» Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during the construction phase.

The foundations for the large wind turbines are the main bulk earth works. The foundations for the large wind turbines are assumed to be square concrete platforms with sides of about 15-20 m in length, sunk about 2.0-3.0 m below ground level. The additional infrastructure involves cabling between the turbines and is assumed to be underground in trenches 0.4 to 1.0 m deep. Road construction may involve borrow pits. Construction of workshops and offices is assumed to involve typical shallow foundation trenches. The small wind turbines proposed for the **Koingnaas WEF** involve a similar degree of limited subsurface penetration.

The Koingnaas project area (40-60 m asl.) is partly underlain by marine deposits, but these are unlikely to be intersected in the small (~1 m deep) excavations intended.

The proposed bulk earth works will affect the terrestrial deposits that blanket the area. These deposits comprise the loose, surficial coversands and the underlying, older, “dorbank” compact, clayey deposits that also are chiefly aeolian sands, with the soils and pedocretes that have formed in them. Fossil bones are sparsely distributed on the palaeosurfaces within these deposits, but are locally abundant in contexts such as interdune deposits, carnivore bone accumulations in burrows and buried Stone Age sites. Trace fossils are ubiquitous and important palaeoenvironmental indicators.

The significance rating is low as a consequence of the low probability of finding fossils in the terrestrial deposits. Impact on palaeontological heritage does not influence the decision to proceed with the projects.

The impact assessment rating method is designed for observable surface environmental processes and features. Whereas fossils are potential treasures buried in the ground and singular objects whose presence cannot be observed *a priori*; a single find may be of international significance. This results in a duality as to significance rating. Successful mitigation may produce a positive benefit of high significance.

Although the 2-3 m deep excavations involved in the installations are of limited depth *cf*. mine quarries and the fossil potential is low overall, the number of excavations involved increases the probability of fossils being turned up.

It is recommended that an alert for the uncovering of fossil bones, fossil shell concentrations and potential Stone Age archaeological material be included in the Construction EMP for the project. In the event of possible fossil and/or archaeological finds, the contracted archaeologist or palaeontologist must be contacted. Appendices 1 and 2 outline monitoring by construction personnel and general Fossil Find Procedures. This is a general guideline, to be adapted to circumstances.

The bulk earthworks involved in the installation of large-scale WEFs (several tens to a few hundred excavations up to 20X20X4 m in size, evenly distributed over large areas) occur in areas where the subsurface would not otherwise be exposed, due to lack of any economic reason. This presents an unprecedented scientific opportunity.

Should such projects proceed, it is recommended that the pits be basically recorded by means of high-resolution images. Key pit sections should identified and described and sampled in more detail. If and when geotechnical data becomes available, such as test/cuts into the different geological substrata in the project areas, this information should be provided to the contracted palaeontologist, in order to better inform the “baseline” of scientific and fossil potential.

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DECLARATION BY THE INDEPENDENT PERSON WHO COMPILED A SPECIALIST REPORT OR UNDERTOOK A SPECIALIST PROCESS

PALAEONTOLOGICAL IMPACT ASSESSMENT (Desktop Study).PROPOSED WIND ENERGY FACILITY ON A PROJECT AREA ON THE NAMAQUALAND COAST, NORTHERN CAPE, INCLUDING

» Koingnaas Wind Energy Facility (Proposed by Just Palm Tree Power)

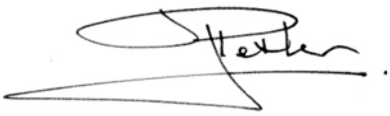
Terms of Reference

This assessment forms part of the Heritage Impact Assessment and it assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of bulk earth works. Mitigatory actions to be taken with respect to the occurrence of fossils during bulk earth works are proposed.

Declaration

I ...**John Pether**......, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in the compilation of the above report;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed to the EAP any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management act;
- have provided the EAP with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543, 2010.



Signature of the specialist. Date: 22 September 2011

The author is an independent consultant/researcher and is a recognized authority in the field of coastal-plain and continental-shelf palaeoenvironments and is consulted by exploration and mining companies, by the Council for Geoscience, the Geological Survey of Namibia and by colleagues/students in academia pursuing coastal-plain/shelf projects.

Expertise

- Shallow marine sedimentology.
- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures and on/offshore cores).
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods).
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).
- Analysis of the shelly macrofauna of modern samples *e.g.* for environmental surveys.

Membership Of Professional Bodies

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Heritage Western Cape. Member, Permit Committee for Archaeology, Palaeontology and Meteorites.
- Accredited member, Association of Professional Heritage Practitioners, Western Cape.

1. INTRODUCTION

This assessment has been prepared at the request of Savannah Environmental (Pty) Ltd. It is the part of the Heritage Impact Assessments in the EIA processes being undertaken by Savannah Environmental for Just Palm Tree Power who propose to establish a wind energy facility (WEF) for generation of electricity on a project area on the Namaqualand coast, Northern Cape (Figure 1).

» Koingnaas Wind Energy Facility (Proposed by Just Palm Tree Power)

Figure 1. Location of the proposed wind energy facility.

The Koingnaas Just Palm Tree Power WEF is much smaller in size than other WEF's generally proposed and involves ~24 small turbines generating less than 10 MW.

This Palaeontological Impact Assessment (PIA) assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface of the project areas and being disturbed or destroyed in the process of making excavations (bulk earth works). The main purposes are to:

- Outline the nature of possible palaeontological heritage resources in the subsurface of the affected areas.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during the construction phases.

2. APPLICABLE LEGISLATION

The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological sites and materials, as well as graves/cemeteries, battlefield sites and buildings, structures and features over 60 years old. The South African Heritage Resources Agency (SAHRA) administers this legislation nationally, with Heritage Resources Agencies acting at provincial level.

According to the Act (Sect. 35), it is an offence to destroy, damage, excavate, alter of remove from its original place, or collect, any archaeological, palaeontological and historical material or object, without a permit issued by the South African Heritage Resources Agency (SAHRA) or applicable Provincial Heritage Resources Agency, *viz*. Heritage Western Cape (HWC).

Notification of SAHRA or the applicable Provincial Heritage Resources Agency is required for proposed developments exceeding certain dimensions (Sect. 38).

3. THRESHOLDS

The areal scale of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 m^2 (NHRA 25 (1999), Section 38 (1)). It must therefore be assessed for heritage impacts (an HIA) that includes assessment of potential palaeontological heritage (a PIA).

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern, such as the foundation trenches for buildings and other installations, the trenches for connecting cabling, water and sanitation piping and water storage dams.

Generally, the foundations for large wind turbines are the main bulk earth works. The additional infrastructure involves cabling between the turbines and is assumed to be underground in trenches 0.4 to 1.0 m deep. Road construction may involve borrow pits. Construction of workshops and offices is assumed to involve typical shallow foundation trenches. The small wind turbines proposed for the Koingnaas WEF involve a similar degree of limited subsurface penetration.

4. APPROACH AND METHODOLOGY

4.1. Available Information

The first descriptions of the geology and fossils from the Namaqualand marine deposits happened when the diamond content was becoming apparent: Haughton (1926), Krige (1927), Wagner & Merensky (1928), Haughton (1928), Reuning (1931), Haughton (1932). The profusion of fossil oysters in the deposits led to the popular perception of an "Oyster Line" associated with diamonds and the realization that sea temperatures along the west coast were once significantly warmer than at present. An important advance for the stratigraphy of Namaqualand coastal deposits was Carrington & Kensley's (1969) article describing new molluscan fossils. Further notes on the deposits of central Namaqualand were provided by Davies (1973) and by Tankard (1975a, 1975b). The coastal-plain history of Namaqualand, as then variously understood, was described and discussed in De Villiers & Söhnge (1959), Hallam (1964), Tankard (1966), Keyser (1972), Tankard & Rogers (1978), Siesser & Dingle (1981), Hendey (1981, 1983a, 1983b, 1983c), Dingle *et al*. (1983), Pether (1986), Gresse (1988) and Rogers *et al*. (1990). Intensive fossil sampling carried out during the writer's research led to considerable additions to the marine molluscan fauna of Namaqualand coastal deposits (Kensley & Pether, 1986). The first extinct Tertiary barnacle recorded from South Africa was described from Hondeklip by Pether (1990). Brunton & Hiller (1990) have described the fossil brachiopods collected by the writer in the Hondeklip study area. Pether (1994) provided detail on the exposures and palaeontology at Hondeklipbaai. More recently, summary texts have been published (Pether *et al*., 2000; Roberts *et al*., 2006).

4.2. Assumptions and Limitations

It is not possible to predict the buried fossil content of an area other than in general terms. In particular, the important fossil bone material is generally sparsely scattered in most deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations. No site-specific information is available, such as geotechnical/engineering reports showing sections exposed in test pits.

4.3. Palaeontological Heritage Management

The rescue of fossils or sampling of fossil content (palaeontological mitigation) cannot usually be done prior to the commencement of excavations for infrastructure and foundations. Palaeontological interventions happen once the EIA process is done, the required approvals have been obtained and excavation of the bulk earth works is proceeding. The intent of palaeontological mitigation is to sample the *in situ* fossil content and describe the exposed, pristine stratigraphic sections.

The action plans and protocols for palaeontological mitigation must therefore be included in the Environmental Management Programme (EMP) for the Construction Phase of the project.

5. GEOLOGICAL AND PALAEONTOLOGICAL SETTING

5.1. Regional Geology

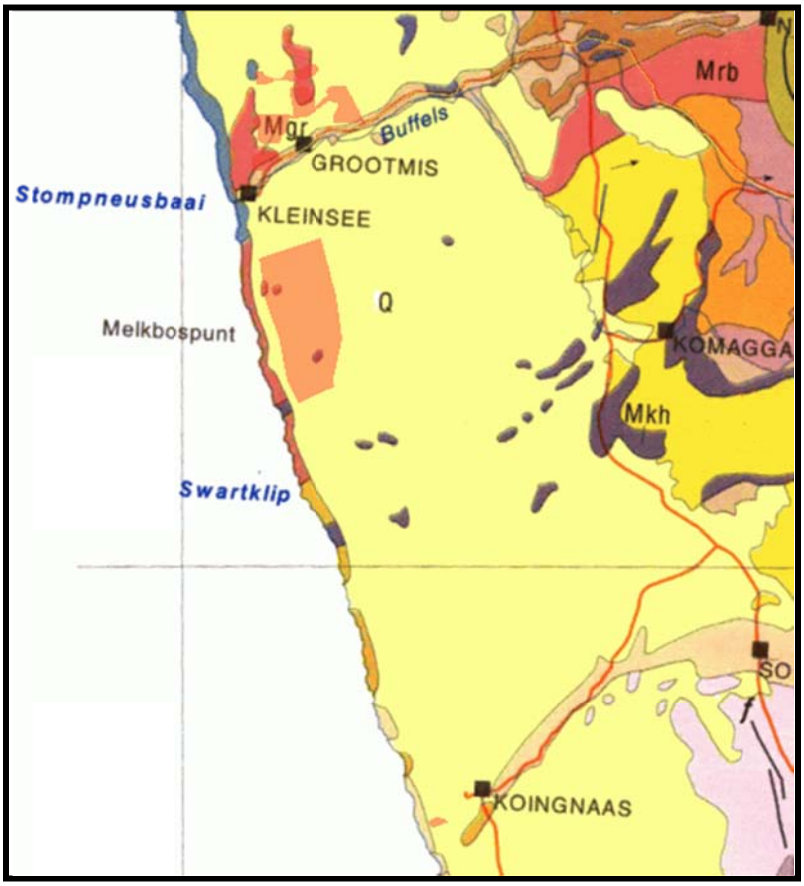


Figure 2. Project areas located on 1:1000000 Geological Map (CGS, 1997).

The large-scale geological map of the region (Figure 2) shows the bedrock largely covered by coastal plain sediments (Q – yellow). The bedrock consists of various granites, gneisses and metasediments and is not of palaeontological interest.

During the early Cretaceous separation of Africa and South America, fault-bound grabens formed parallel to the approximately N-S bedrock structural grain during crustal extension and collapse along the early coastline. Dolerite dykes intruded the faults and lineaments in the basement, with volcanic activity in places. Vigorous erosion during the later Cretaceous exposed the coastal bedrock of metasediments and gneisses from beneath a cover of Nama and Dwyka rocks. Deposits from these times are only preserved in rare instances, One example, a graben fill preserved some distance to the north of Kleinzee, contains lacustrine deposits that have yielded Lower Cretaceous pollen (Molyneux, in Rogers *et al*., 1990), indicating deposition 145-130 Ma.

The coastal plain would have been transgressed during later Cretaceous high sea-levels. Transgressive Eocene events also affected the coastal plain and deposits of this epoch are found in southern Namibia, but little evidence of this earlier marine history remains along Namaqualand. Rather, much of the further evolution of the coastal drainages took place during these times, with flushing of pre-existing deposits to the offshore depositories. The coastal plain bedrock became deeply weathered and kaolinized under the influence of the humid tropical climates of the later Cretaceous and early Tertiary, with silcrete duricrusts developing.

Incised into this ancient, weathered land surface are remnants of fluvial palaeochannels, whose infills have also been kaolinized, disguising their presence (informally called the "Channel Clays", but now named the **Koingnaas Formation** (de Beer, in prep.). These channel sediments have basal conglomerates, locally rich in diamonds, overlain by beds of clayey sand, clay and peat beds very rich in plant macrofossils, wood and pollen (Molyneux, in Rogers *et al*., 1990). The fossils date from between 40-20 Ma, when yellowwood forest with ironwoods dominated the West Coast. Tropical mahogany wood has been found and these deposits contain about the earliest daisy pollen known.

Overlying the bedrock, or in places the aforementioned deposits, are three extensive marine formations containing warm-water mollusc assemblages (fossil shells). The marine deposits are found below bedrock elevations of ~90 m asl. The bedrock has been eroded and bevelled during its submergence and wave-cut platforms and "fossil cliffs" occur. Along the inner, high part of the coastal bevel is the **Kleinzee Formation** of Miocene age 16-14 Ma. Truncating and onlapping it along the middle part of the coastal bevel is the **Avontuur Formation** of early Pliocene age 5-4 Ma. Truncating and onlapping this along the outer part of the coastal bevel is the **Hondeklipbaai Formation** of mid-Pliocene age 3.5-3 Ma.

Close to the seaside, the Hondeklipbaai Formation is eroded and overlain by the younger, Quaternary "raised beaches" that extend up to about 15 m asl. and that include cold-water shell assemblages. The name **Curlew Strand Formation** has been proposed for this composite of beaches, equivalent to the Velddrif Formation of the SW Cape Coast.

A variety of terrestrial deposits overlie the eroded tops of the marine sequences and make up the coastal plain of the Namaqualand. For the most part these are extensive aeolian dune and sandsheet deposits . A number of formations are recognized in southern Namaqualand (de Beer, in prep.). The writer has recognized aeolian formations of later Miocene, mid-Pliocene, late Pliocene and various Quaternary ages. Locally interbedded in the aeolianites are colluvial (sheetwash) and ephemeral stream deposits associated with nearby hill slopes. Sometimes these underlie or are interbedded between the marine formations. Formed within these terrestrial sequences are pedocretes and palaeosols of a variety of types, compositions and degrees of development. Interbedded pan deposits also occur.

The older terrestrial deposits are compact, reddened sands with a hard surface under the loose coversands, colloquially termed "dorbank". Dorbank has formed by the pedogenic alteration of older aeolianites, involving the formation of red-brown clay and various degrees of incipient cementing. Pedocretes, such as calcrete, are variously developed within it. The "dorbank" is thicker (>10 m) inland where it is distinctly bedded, has interbedded pan deposits and has accumulated over a longer time.

The younger, white to lightly-reddened coversands and dunes have been cored by Chase & Thomas (2007), whom applied optically stimulated luminescence (OSL) dating techniques to establish the timing of sand accumulation. Their results indicate activity/deposition at various times during the last ~80 ka (4–5, 16–24, 30–33, 43–49 and 63–73 ka). Underlying sandy soils produced dates from ~150 to ~300 ka, reflecting the accumulation of sand sheets during the middle Quaternary (the redder sands).

5.2. Namaqualand Vertebrate Palaeontology

The vertebrate fossils (bones, teeth) found in the coastal plain deposits are absolutely critical for the provision of age constraints. The sample of identifiable fossil bones and teeth from coastal Namaqualand is small (see tables in Pickford & Senut, 1997) and currently is just sufficient to provide age constraints that support correlations with gross sea-level/ice-volume history. Nevertheless, study of the Hondeklip exposures have demonstrated that there are more bone/teeth fossils in the deposits than is generally perceived, as has been revealed by dedicated searching. These occur in the following contexts:

- Basal, petrified, mixed assemblage: petrified (phosphatized), variously abraded, reworked fossils found the basal gravels and that predate the enclosing marine deposits. Includes both terrestrial and marine vertebrates.

- The marine assemblage: cetacean, seabird and seal fossils contemporaneous with the enclosing marine deposits. Input of terrestrial bones is associated with local back-barrier environments (lagoons, tidal channel lags).

- The capping, terrestrial assemblage: Bones of land animals common on the extensive palaeosurface erosively formed on the marine deposits.

» Overlying terrestrial deposits: Mainly aeolianites (dune, interdune/pan and sandsheet deposits), locally with colluvial and ephemeral streamwash deposits. Rare bones occur on palaeosurfaces within these sequences. Fossils are more common in interdune deposits.

From Buffels River fluvial deposits at ~35 m asl. near Kleinzee, Stromer (1931) described a small vertebrate assemblage that included extinct hyaena, otter and mongoose bones. Thereafter, no major assemblages were recovered, but a trickle of finds were presented for identification through the many years of mining (Hendey, 1984). During research at Hondeklip mine, a special effort was made to improve the situation, involving painstaking scrutiny of the exposures. Some of this well-provenanced material, and new finds from the Hondeklip area, have now been examined systematically (Pickford and Senut, 1997), shedding new light on coastal plain history.

Fossilized teeth of suids (pigs) and a hominoid tooth, recovered from Kleinzee Formation marine basal gravels are of latest early Miocene age (18 - 17.5 Ma) (Pickford & Senut, 1997). These terrestrial fossils were eroded from terrestrial deposits by the encroaching sea in the vanguard of the mid-Miocene transgression. The Avontuur Formation also contains a basal concentration of petrified and abraded vertebrate remains inherited from earlier periods. This "Basal, petrified, mixed assemblage" or remanié fauna includes shark teeth and the bones and teeth of extinct whales, proboscideans, rhinocerotids, bovids and equids (Pether, 1994; Pickford and Senut, 1997). The oldest fossils present are the bear-dog *Agnotherium* sp. (13 - 12 Ma) and the gomphothere *Tetralophodon* (12 - 9 Ma), but the age indicated by most of the material is terminal Miocene (7.5 - 5 Ma) (Pickford and Senut, ibid.). These youngest taxa in the reworked basal assemblage constrain the maximum age of the Avontuur Formation. The important, unpetrified finds from within the formation are the Langebaanian (Varswater) phocid (seal) *Homiphoca capensis* and the suid (bushpig) *Nyanzachoerus kanamensis*, the latter reported by Pickford & Senut (1997) to have an age of 5 - 7 Ma. Stromer's (1931) assemblage includes Langebaanian carnivores (Hendey, 1984). Linking of the Avontuur Formation to the Varswater Formation and the early Pliocene (~5 Ma) high sea level is therefore considered appropriate.

The top of the Avontuur Formation in the Hondeklip area is eroded away and a cryptic contact separates pristine marine sediments and reworked marine sediments. On the cryptic surface are sparsely scattered bones (tortoise, zebra, ostrich, jackal, various antelopes, rhino). This erosion surface and the overlying terrestrial sediments must be younger than the ~2.6 Ma *Equus* (horses) dispersal in Africa because of the zebra (*Equus capensis*) bones. The jaw of a species of gazelle found there is the likely ancestor of the springbok.

Fossils are rare in the overlying "dorbank" aeolianites, but inspections of extensive mine exposures often produces results. Their contexts are discussed further in Section 6.4.

6. EXPECTED PALAEONTOLOGY

6.1. Koingnaas Just Palm Tree Power WEF

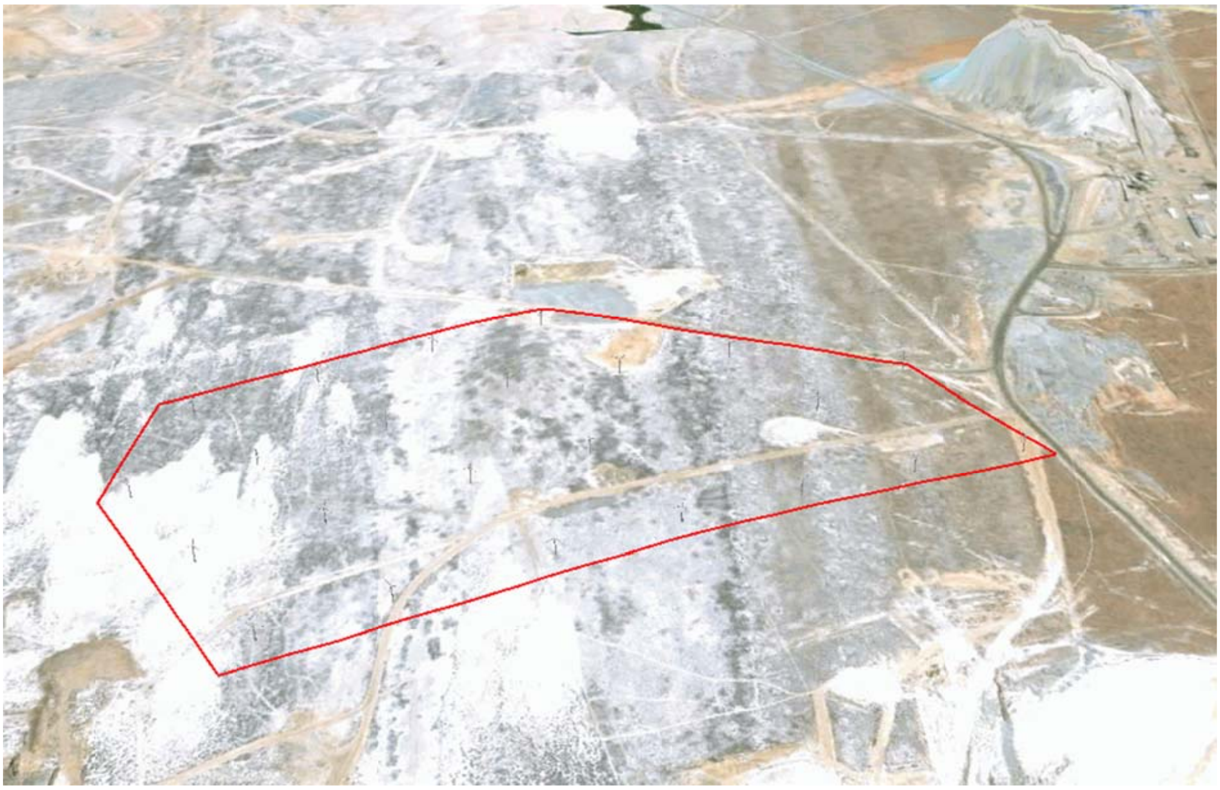


Figure 7. Koingnaas Just Palm Tree Power project area in simulated oblique aerial view looking northwards. Google Volfkop

This small project area (Figure 7) is mainly between elevations of 40 to 60 m asl. and is situated on the bedrock high that crops out as the gentle hill of Wolfkop in the north-central part, where the bedrock is thinly covered between 60-70 m asl. Thin, residual marine deposits lap around Wolfkop (early Pliocene Avontuur Formation). The marine deposits seen in nearby mine pits are decalcified (personal obs.), but petrified fossils occur. However, the marine beds are overlain by terrestrial deposits and ~1 m of calcrete and are not expected to be intersected in most shallow excavations <1 m deep.

There is a low probability that terrestrial fossils may be found in the calcrete capping the older deposits. The area is overlain by pale, recently-mobile sands; buried fossil bones and shell may be found within and beneath these sands, but will most likely be in an archaeological context.

6.2. Palaeontological Contexts

The surface sands and underlying “dorbank” compact deposits have accumulated intermittently, forming buried, stable surfaces (palaeosurfaces), where time has permitted fossils to accumulate. These are marked by soils and pedocretes, within which fossils are quite common. The common fossils include shells of land snails and bones/shells of fossil tortoises, rodents, moles, birds, ostrich incl. egg fragments, sparsely scattered bones etc. Trace fossils such as calcified termitaria and termite burrows, other insect burrows and fossil root casts are common, as are mole burrows. More rarely, ancient, infilled aardvark burrows may be uncovered. These may have been exploited by hyaenas and other carnivores, who make spectacular concentrations of bones in them. “Blowout” erosional palaeosurfaces may carry fossils concentrated by the removal of sand by the wind. Local hollows (interdunes) are the sites of ponding of water seeping from the surrounding sands, leading to the deposits of seeps and pans/vleis. Being water sources, such may be richly fossiliferous. On hillsides are colluvial deposits and ephemeral watercourse deposits which are poorly fossiliferous, but abraded bone fragments and loose teeth may occur sparsely in channel lags.

6.3. Buried Archaeological Material

A notable feature of the hard palaeosurface beneath the loose coversands and capping the “dorbank” is the occurrence of Middle Stone Age (MSA) implements and archaeological bone scatters. Early Stone Age (ESA) “Acheulian” artefacts and manuports occur in the upper part of the “dorbank”.

7. SIGNIFICANCE

Fossil finds in this context stand to have heritage/scientific benefits in increasing the knowledge of the coversands of the coastal plain. The various periods during which the coversand formations and the underlying formations (older aeolian sands) were deposited in different areas are not well-constrained by fossil evidence, as very few fossils have been collected/rescued. Only recently has a modern dating method (OSL) been applied at a few localities (Chase & Thomas, 2007).

Past discoveries show that the fossil potential within and beneath coversands and dunes can be very significant. The most well-studied is Elandsfontein, where blowouts of the coversand exposed thousands of underlying fossil bones and Stone Age tools, the occurrence of which is associated with a fossil vlei formed due to higher water tables in the past (Klein *et al*., 2007). Notably, prior to the wind erosion of coversands at Elandsfontein, there would have been no indication of the fossil wealth just below. At Geelbek Dunefield the deflation hollows located between the wind-blown, actively-mobile sand dunes are a source of mammalian fossils and Stone Age tools, with more being constantly exposed (Kandel *et al*., 2003). The aeolianite ridge stretching north from Saldanha Bay to Paternoster has been found to include fossil eggshell fragments of an extinct ostrich

(*Diamantornis wardi*) and extinct land snail forms (Roberts & Brink, 2002). The dating of *Diamantornis wardi* occurrences in Namibia, East Africa and Arabia indicates an age of 12-9 Ma (Stidham, 2008), making this one of the oldest coastal dune systems in South Africa. These fossil localities have attracted international attention.

Although the 2-3 m deep excavations involved in the installations are of limited depth *cf*. mine quarries and the fossil potential is low overall, the number of excavations involved increases the probability of fossils being turned up. Mitigation during the construction phase of the proposed project has the potential for further discoveries that stand to have heritage/scientific benefits.

In summary, the significance of fossils that may be found involves:

» Significance in the history of coastal-plain evolution.

» Significance for the history of past climatic changes.

» Significance in the history of past biota and environments.

» Associations of fossils with buried archaeological material and human prehistory.

» For radiometric and other dating techniques (rates of coastal change).

» Preservation of materials for the application of yet unforeseen investigative techniques.

There is a significance to fossils beyond their conventional academic/scientific importance that is more firmly in the realm of cultural aesthetics. Culture is embedded in land/place/animals and fossils are part of the physical strata of the landscape. Fossils inform the appreciation of the space-time depth of landscape and its biota, living and extinct. Such realizations are inspired by encounters with fossils. Ultimately this heritage resource must be rendered known and accessible to the wider community *via* educational programmes emanating from *e.g*. museums, sponsorship, NGOs. The first priority, however, is to rescue fossils and attendant information that would otherwise be lost.

There is a potential positive socio-economic impact to a significant find of fossils. This may be minor and short-term, *e.g*. the local spending involved in labour and supplies for the fieldwork to excavate the find. It may bring long-term benefits, such as the establishment of a local museum and tourist attraction. Corporate involvement in sponsorship of such initiatives is demonstrative of social responsibility.

8. NATURE OF THE IMPACT OF BULK EARTH WORKS ON FOSSIL HERITAGE

Fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be sporadically preserved and have high value w.r.t. palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

When excavations are made they furnish the “windows” into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, <u>provided that efforts are made to watch out for and rescue the fossils</u>. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

The status of the potential impact for palaeontology is not neutral or negligible.

Although coastal coversands are not generally very fossiliferous, it is quite possible that fossiliferous material could occur. The very scarcity of fossils makes for the added importance of them being sought.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Machinery involved in excavation may damage or destroy fossils, or they may be hidden in “spoil” of excavated material. Worse, they may simply be ignored as “Just another bone”.

9. IMPACT ASSESSMENT

The project area is situated with respect to the probability of fossils being uncovered.

9.1. Extents

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance during construction.

The cultural, heritage and scientific impacts are of regional to national extent, as is implicit in the NHRA 25 (1999) legislation and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded research that takes place by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels.

9.2. Duration

According with the above, the physical duration of the impact is short term (<5 years) and primarily related to the period over which foundations, trenches and other infrastructural excavations are made. This is the "time window" for mitigation.

Again, the impact of both the finding or the loss of fossils is permanent. The found fossils must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity.

9.3. Magnitude

The affected deposits have low fossil potential and therefore the intensity of impact is rated moderate to low. Notwithstanding, the possibility of fossils being encountered in diggings cannot be totally excluded and the potential impact of bulk earth works on fossil resources is higher in the absence of mitigation. As mentioned, it is quite likely that scientifically valuable fossils may be lost in spite of mitigation.

9.4. Probability

The likelihood of impact is improbable in this context (Could occur, but low likelihood under most circumstances).

9.5. Confidence

The level of confidence of the probability and intensity of impact is medium.

9.6. Summary table

Nature

Bulk earth works may result in a negative direct impact on the fossil content of the affected subsurface. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

Conversely, bulk earth works furnish the “windows” into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, provided that efforts are made to watch out for and rescue the fossils. There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss.

The cumulative impact of bulk earth works associated with ongoing various developments is the permanent loss of fossil heritage, or with effective mitigation, the capture and preservation of some fraction of the valuable specimens for posterity.

Impact on Fossil Resource	**Without mitigation**	**With mitigation**
Extent	3-5 (regional-international)	3-5 (regional-international)
Duration	5 (permanent loss)	5 (part loss, part gain, perm.)
Magnitude	6 (moderate)	4 (partly rescued)
Probability	2	2
Significance	**28-32**	**24-28**
Status	Negative	Positive
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Possible loss	Possible gain
Can impacts be mitigated?	Partly	
Mitigation:	Monitoring and inspection of construction-phase excavations	

The significance rating is low as a consequence of the low probability of finding fossils in the upper terrestrial deposits. However, note that the impact assessment rating method is designed for observable surface environmental processes and features. Whereas fossils are potential treasures buried in the ground and singular objects whose presence cannot be observed *a priori*; a single find may be of international significance. This results in a duality as to significance rating. Successful mitigation may produce a positive benefit of high significance.

10. RECOMMENDATIONS

The potential impact has a moderate influence upon the proposed development, consisting of implemented mitigation measures recommended below, to be followed during the construction phase.

As outlined above, the potential for finding important fossils, although low, is not altogether lacking. Interventions are particularly required if bones are turned up during excavation. These are rare and valuable and every effort should be made to spot them and effect rescue of them.

It is recommended that an alert for the uncovering of fossil bone and implements be included in the EMP for the project.

In the event of possible fossil and/or archaeological finds, the contracted archaeologist or palaeontologist must be contacted.

Appendices 1 and 2 outline monitoring by construction personnel and general Fossil Find Procedures. This is a general guideline, to be adapted to circumstances.

10.1. Monitoring

OBJECTIVE: To see and rescue fossil material that may be exposed in the various excavations made for installation foundations and cabling.	
Project components	Foundation excavations for wind turbines. Foundation excavations for substations. Trenches for cabling linking turbines and substations. Spoil from excavations.
Potential impact	Loss of fossils by their being unnoticed and/ or destroyed.

Activity / risk source	All bulk earthworks.	
Mitigation: target / objective	To facilitate the likelihood of noticing fossils and ensure appropriate actions in terms of the relevant legislation.	
Mitigation: Action / control	**Responsibility**	**Timeframe**
Inform staff of the need to watch for potential fossil occurrences.	Developer, Savannah, ECO, contractors.	Pre-construction.
Inform staff of the procedures to be followed in the event of fossil occurrences.	ECO/specialist.	Pre-construction.
Monitor for presence of fossils	Contracted personnel and ECO.	Construction.
Liaise on nature of potential finds and appropriate responses.	ECO and specialist.	Construction.
Retrieve main finds and record contexts.	Specialist.	Construction.
Obtain permit from HWC for finds.	Specialist.	Construction
Performance Indicator	Reporting of and liaison about possible fossil finds. Fossils noticed and rescued.	
Monitoring	Due effort to meet the requirements of the monitoring procedures.	

10.2. Scientific Heritage Opportunity

The bulk earthworks involved in the installation of large-scale WEFs (several tens to a few hundred excavations up to 20X20X4 m in size) presents an unprecedented scientific opportunity. These pits are “windows” into coastal-plain geological and palaeoenvironmental history. They will be made in areas where the subsurface would not otherwise be exposed, due to lack of any economic reason. Evenly distributed over large areas, the foundation pits sample the subsurface of an area very effectively.

Should such projects proceed, it is recommended that the pits be basically recorded by means of high-resolution images. Key pit sections should identified and described and sampled in more detail.

If and when geotechnical data becomes available, such as test/cuts into the different geological substrata in the project areas, this information should be provided to the contracted palaeontologist, in order to better inform the "baseline" of scientific and fossil potential.

With permissions of the owner and developer, the contracted specialist should be allowed to identify and inform other scientists/institutions potentially interested in exercising the opportunity to make observations and obtain samples (*e.g*. for OSL dating).

11. APPLICATION FOR A PALAEONTOLOGICAL PERMIT

A permit from SAHRA is required to excavate fossils. The applicant should be the qualified specialist responsible for assessment, collection and reporting (palaeontologist).

Should fossils be found that require rapid collecting, application for a retrospective palaeontological permit must be made to SAHRA immediately.

The application requires details of the registered owners of the sites, their permission and a site-plan map.

All samples of fossils must be deposited at a SAHRA-approved institution.

12. REPORTING

Should fossils be found a detailed report on the occurrence/s must be submitted. This report is in the public domain and copies of the report must be deposited at the IZIKO S.A. Museum, McGregor Museum and SAHRA. It must fulfil the reporting standards and data requirements of these bodies.

The report should be in standard scientific format, basically:

» A summary/abstract.

» Introduction.

» Previous work/context.

» Observations (incl. graphic sections, images).

» Palaeontology.

» Interpretation.

» Concluding summary.

» References.

» Appendices

The draft report should be reviewed by the client, or externally, before submission of the Final Report.

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14. GLOSSARY

~ (tilde): Used herein as "approximately" or "about".

Aeolian: Pertaining to the wind. Refers to erosion, transport and deposition of sedimentary particles by wind. A rock formed by the solidification of aeolian sediments is an aeolianite.

AIA: Archaeological Impact Assessment.

Alluvium: Sediments deposited by a river or other running water.

Archaeology: Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

asl.: above (mean) sea level.

Bedrock: Hard rock formations underlying much younger sedimentary deposits.

Calcareous: sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite.

Calcrete: An indurated deposit (duricrust) mainly consisting of Ca and Mg carbonates. The term includes both pedogenic types formed in the near-surface soil context and non-pedogenic or groundwater calcretes related to water tables at depth.

Clast: Fragments of pre-existing rocks, *e.g*. sand grains, pebbles, boulders, produced by weathering and erosion. Clastic – composed of clasts.

Colluvium: Hillwash deposits formed by gravity transport downhill. Includes soil creep, sheetwash, small-scale rainfall rivulets and gullying, slumping and sliding processes that move and deposit material towards the foot of the slopes.

Coversands: Aeolian blanket deposits of sandsheets and dunes.

Duricrust: A general term for a zone of chemical precipitation and hardening formed at or near the surface of sedimentary bodies through pedogenic and (or) non-pedogenic processes. It is formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upward, downward, or laterally by capillary action, commonly assisted in arid settings by evaporation. Classified into calcrete, ferricrete, silcrete.

ECO: Environmental Control Officer.

EIA: Impact Assessment.

EMP: Environmental Management Plan.

ESA: Early Stone Age. The archaeology of the Stone Age between 2 000 000 and 250 000 years ago.

Ferricrete: Indurated deposit (duricrust) consisting predominantly of accumulations of iron sesquioxides, with various dark-brown to yellow-brown hues. It may form by deposition from solution or as a residue after removal of silica and alkalis. Like calcrete it has pedogenic and groundwater forms. Synonyms are laterite, iron pan or "koffieklip".

Fluvial deposits: Sedimentary deposits consisting of material transported by, suspended in and laid down by a river or stream.

Fm.: Formation.

Fossil: Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Graben: A depressed block of land/crust bordered by parallel faults.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

HIA: Heritage Impact Assessment.

LIG: Last Interglacial. Warm period 128-118 ka BP. Relative sea-levels higher than present by 4-6 m. Also referred to as Marine Isotope Stage 5e or "the Eemian".

LSA: Late Stone Age. The archaeology of the last 20 000 years associated with fully modern people.

Midden: A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.

MSA: Middle Stone Age. The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.

OSL: Optically stimulated luminescence. One of the radiation exposure dating methods based on the measurement of trapped electronic charges that accumulate in crystalline materials as a result of low-level natural radioactivity from U, Th and K. In OSL dating of aeolian quartz and feldspar sand grains, the trapped charges are zeroed by exposure to daylight at the time of deposition. Once buried, the charges accumulate and the total radiation exposure (total dose) received by the sample is estimated by laboratory measurements. The level of radioactivity (annual doses) to which the sample grains have been exposed is measured in the field or from the separated minerals containing radioactive elements in the sample. Ages are obtained as the ratio of total dose to annual dose, where the annual dose is assumed to have been similar in the past.

Palaeontology: The study of any fossilised remains or fossil traces of animals or plants which lived in the geological past and any site which contains such fossilised remains or traces.

Palaeosol: An ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in the area where the soil is found. Burial reflects the subsequent environmental change.

Palaeosurface: An ancient land surface, usually buried and marked by a palaeosol or pedocrete, but may be exhumed by erosion (*e.g*. wind erosion/deflation) or by bulk earth works.

Peat: partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Pedocrete: A duricrust formed by pedogenic processes.

Pedogenesis/pedogenic: The process of turning sediment into soil by chemical weathering and the activity of organisms (plants growing in it, burrowing animals such as worms, the addition of humus *etc.*).

PIA: Palaeontological Impact Assessment.

SAHRA: South African Heritage Resources Agency – the compliance authority, which protects national heritage.

Stone Age: The earliest technological period in human culture when tools were made of stone, wood, bone or horn. Metal was unknown.

14.1. Geological Time Scale Terms (youngest to oldest).

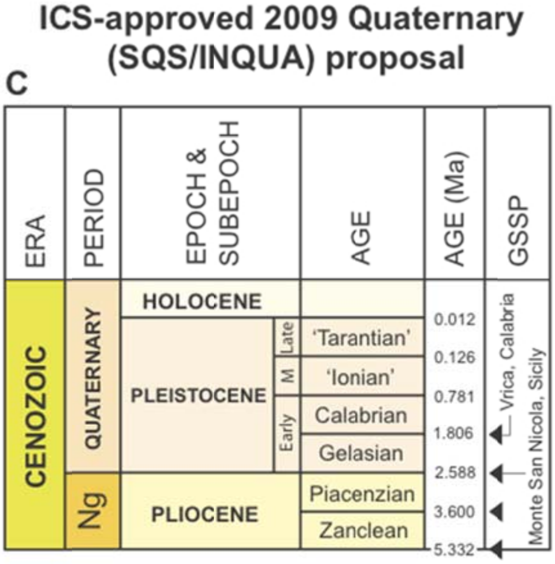
ka: Thousand years or kilo-annum (10^3 years). Implicitly means “ka ago” *i.e*. duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Generally not used for durations not extending from the Present. Sometimes “kyr” is used instead.

Ma: Millions years, mega-annum (10^6 years). Implicitly means “Ma ago” *i.e.* duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Generally not used for durations not extending from the Present.

Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka. Late Pleistocene 11.7–126 ka. Middle Pleistocene 135–781 ka. Early Pleistocene 781–2588 ka (0.78-2.6.Ma).

Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era. The Quaternary includes both the Pleistocene and Holocene epochs. The terms early, middle or late in reference to the Quaternary should only be used with lower case letters because these divisions are informal and have no status as divisions of the term Quaternary. The sub-divisions 'Early', 'Middle' or 'Late' apply only to the word Pleistocene. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the



Holocene.

Pliocene: Epoch from 5.3-2.6 Ma.

Miocene: Epoch from 23-5 Ma.

Oligocene: Epoch from 34-23 Ma.

Eocene: Epoch from 56-34 Ma.

Paleocene: Epoch from 65-56 Ma.

Cenozoic: Era from 65 Ma to the present. Includes Paleocene to Holocene epochs.

Cretaceous: Period in the Mesozoic Era, 145-65 Ma.

Jurassic: Period in the Mesozoic Era, 200-145 Ma.

Precambrian: Old crustal rocks older than 542 Ma (pre-dating the Cambrian).

15. APPENDIX 1 – MONITORING FOR FOSSILS

A regular monitoring presence over the period during which excavations are made, by either an archaeologist or palaeontologist, is generally not practical.

The field supervisor/foreman and workers involved in digging excavations must be encouraged and informed of the need to watch for potential fossil and buried archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the ECO. The ECO will inform the archaeologist and/or palaeontologist contracted to be on standby in the case of fossil finds.

To this end, responsible persons must be designated. This will include hierarchically:

» The field supervisor/foreman, who is going to be most often in the field.

» The Environmental Control Officer (ECO) for the project.

» The Project Manager.

Should the monitoring of the excavations be a stipulation in the Archaeo-logical Impact Assessment, the contracted Monitoring Archaeologist (MA) can also monitor for the presence of fossils and make a field assessment of any material brought to attention. The MA is usually sufficiently informed to identify fossil material and this avoids additional monitoring by a palaeontologist. In shallow coastal excavations, the fossils encountered are usually in an archaeological context.

The MA then becomes the responsible field person and fulfils the role of liaison with the palaeontologist and coordinates with the developer and the Environmental Control Officer (ECO). If fossils are exposed in non-archaeological contexts, the palaeontologist should be summoned to document and sample/collect them.

16. APPENDIX 2 - FOSSIL FIND PROCEDURES

In the context under consideration, it is improbable that fossil finds will require declarations of permanent “no go” zones. At most a temporary pause in activity at a limited locale may be required. The strategy is to rescue the material as quickly as possible.

The procedures suggested below are in general terms, to be adapted as befits a context. They are couched in terms of finds of fossil bones that usually occur sparsely, such as in the aeolian deposits. However, they may also serve as a guideline for other fossil material that may occur.

In contrast, fossil shell layers are usually fairly extensive and can be easily documented and sampled (See section 15.5).

Bone finds can be classified as two types: isolated bone finds and bone cluster finds.

16.1. Isolated Bone Finds

In the process of digging the excavations, isolated bones may be spotted in the hole sides or bottom, or as they appear on the spoil heap. By this is meant bones that occur singly, in different parts of the excavation. If the number of distinct bones exceeds 6 pieces, the finds must be treated as a bone cluster (below).

16.1.1. Response by personnel in the event of isolated bone finds

» Action 1: An isolated bone exposed in an excavation or spoil heap must be retrieved before it is covered by further spoil from the excavation and set aside.

» Action 2: The site foreman and ECO must be informed.

» Action 3: The responsible field person (site foreman or ECO) must take custody of the fossil. The following information to be recorded:

- * Position (excavation position).
- * Depth of find in hole.
- * Digital image of hole showing vertical section (side).
- * Digital image of fossil.

» Action 4: The fossil should be placed in a bag (e.g. a Ziplock bag), along with any detached fragments. A label must be included with the date of the find, position info., depth.

» Action 5: ECO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

16.1.2. Response by Palaeontologist in the event of isolated bone finds

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established.

16.2. Bone Cluster Finds

A bone cluster is a major find of bones, i.e. several bones in close proximity or bones resembling part of a skeleton. These bones will likely be seen in broken sections of the sides of the hole and as bones appearing in the bottom of the hole and on the spoil heap.

16.2.1. Response by personnel in the event of a bone cluster find

» Action 1: Immediately stop excavation in the vicinity of the potential material. Mark (flag) the position and also spoil that may contain fossils.

» Action 2: Inform the site foreman and the ECO.

» Action 3: ECO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

16.2.2. Response by Palaeontologist in the event of a bone cluster find

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. It is likely that a Field Assessment by the palaeontologist will be carried out asap.

It will probably be feasible to “leapfrog” the find and continue the excavation farther along, or proceed to the next excavation, so that the work schedule is minimally disrupted. The response time/scheduling of the Field Assessment is to be decided in consultation with developer/owner and the environmental consultant.

The field assessment could have the following outcomes:

» If a human burial, the appropriate authority is to be contacted (see AIA). The find must be evaluated by a human burial specialist to decide if Rescue Excavation is feasible, or if it is a Major Find.

» If the fossils are in an archaeological context, an archaeologist must be contacted to evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

» If the fossils are in an palaeontological context, the palaeontologist must evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

16.3. Rescue Excavation

Rescue Excavation refers to the removal of the material from the just the “design” excavation. This would apply if the amount or significance of the exposed material appears to be relatively circumscribed and it is feasible to remove it without compromising contextual data. The time span for Rescue Excavation should be reasonably rapid to avoid any or undue delays, e.g. 1-3 days and definitely less than 1 week.

In principle, the strategy during mitigation is to "rescue" the fossil material as quickly as possible. The strategy to be adopted depends on the nature of the occurrence, particularly the density of the fossils. The methods of collection would depend on the preservation or fragility of the fossils and whether in loose or in lithified sediment. These could include:

» On-site selection and sieving in the case of robust material in sand.

» Fragile material in loose/crumbly sediment would be encased in blocks using Plaster-of Paris or reinforced mortar.

If the fossil occurrence is dense and is assessed to be a "Major Find", then carefully controlled excavation is required.

16.4 Major Finds

A Major Find is the occurrence of material that, by virtue of quantity, importance and time constraints, cannot be feasibly rescued without compromise of detailed material recovery and contextual observations.

A Major Find is not expected.

16.4.1. Management Options for Major Finds

In consultation with developer/owner and the environmental consultant, the following options should be considered when deciding on how to proceed in the event of a Major Find.

» Option 1: Avoidance

Avoidance of the major find through project redesign or relocation. This ensures minimal impact to the site and is the preferred option from a heritage resource management perspective. When feasible, it can also be the least expensive option from a construction perspective.

The find site will require site protection measures, such as erecting fencing or barricades. Alternatively, the exposed finds can be stabilized and the site refilled or capped. The latter is preferred if excavation of the find will be delayed substantially or indefinitely. Appropriate protection measures should be identified on a site-specific basis and in wider consultation with the heritage and scientific communities.

This option is preferred as it will allow the later excavation of the finds with due scientific care and diligence.

» Option 2: Emergency Excavation

Emergency excavation refers to the "no option" situation wherein avoidance is not feasible due to design, financial and time constraints. It can delay construction and emergency excavation itself will take place under tight time constraints, with the potential for irrevocable compromise of scientific quality. It could involve the removal of a large, disturbed sample by excavator and conveying this by truck from the immediate site to a suitable place for “stockpiling”. This material could then be processed later.

Consequently, emergency excavation is not a preferred option for a Major Find.

16.5 Exposure Of Fossil Shell Beds

16.5.1. Response by personnel in the event of intersection of fossil shell beds

» Action 1: The site foreman and ECO must be informed.

» Action 2: The responsible field person (site foreman or ECO) must record the following information:

* Position (excavation position).
* Depth of find in hole.
* Digital image of hole showing vertical section (side).
* Digital images of the fossiliferous material.

» Action 3: A generous quantity of the excavated material containing the fossils should be stockpiled near the site, for later examination and sampling.

» Action 4: ECO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

16.5.2. Response by Palaeontologist in the event of fossil shell bed finds

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. This will most likely be a site visit to document and sample the exposure in detail, before it is covered up.