PALAEONTOLOGICAL ASSESSMENT
(Desktop Study)

PROPOSED ESKOM PHANTOM SUBSTATION, RHEENENDAL AREA, KNYSNA, WESTERN CAPE

By

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For

ESKOM HOLDINGS LIMITED
Distribution Division, Western Operating Unit

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SUMMARY

Eskom proposes to construct a new substation near Knysna, to be called the **Phantom Substation** (Figure 1). The Phantom Substation is required to accommodate the current load as well as future demand for electricity in the area. ***Landscape Dynamics Environmental Consultants*** has been appointed by Eskom Holdings Limited to undertake a Basic Assessment for the proposed substation. Three site alternatives with associated powerline routes have been identified (Figure 1). The sites are situated relatively closely to each other next to the Rheenendal Road. The properties that are involved are Farm 191, Portions 44 and 45 (Sites 1 & 2) and the Remainder of Farm 488 (Site 3).

This Palaeontological Impact Assessment (PIA) is part of the Heritage Impact Assessment (HIA). For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations that are the main concern. The foundations for the new substation are not expected to exceed 1 m in depth. The dimensions of the footings for the powerline pylons are not specified, but the sites are situated on coversands that generally are soft. Consequently footings may extend to ~3-4 m depth.

The 3 sites are below the +200 m asl. edge of the "Coastal Platform" and are underlain by the **reworked coversands** and are not distinguished in terms of palaeontological sensitivity. Dating of these sands indicates that they were redeposited during the mid-Quaternary and also probably earlier. ESA tools (Achuelean) have been found at several places within these coversands, such toolmaking dating back to ~1 Ma. Hitherto no fossils have been recorded from the coversands, apparently due to their decalcification and pedogenic history.

Coversand thicknesses of 3-6 m are recorded in the vicinities of the sites so it seems unlikely that earth works for the installations will be deep enough to encounter the underlying deposits of the Uitenhage Group such as the palaeontologically-sensitive Kirkwood Formation. Similarly, it seems unlikely that underlying Knysna Formation lignites will be encountered.

The coversands have low palaeontological sensitivity. Notwithstanding, there is a small possibility that a fortuitous fossil find may occur. Sometimes the bones of large animals (elephant, buffalo, rhino) occur in coversands and dunes. Such could feasibly survive in some form in the pedogenic environment of the Knysna coversands. Fossils may also occur in an imperfectly preserved form such as concretions or nodules formed in cavities.

It is recommended that the excavations and excavated material be monitored by construction personnel for the occurrence of archaeological material and possible fossils. Appendices 1 and 2 outline monitoring and provide general Fossil Find Procedures. In the event of a potential fossil find, the Manager/Environmental Officer must inform the contracted palaeontologist who must assess the information and liaise in the establishing of a suitable response.

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).

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.

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1 INTRODUCTION

Eskom Holdings Limited, represented by Eskom Distribution Land Development, Western Operating Unit, propose to construct a new substation near Knysna, to be called the **Phantom Substation** (Figure 1). The Phantom Substation is required to accommodate the current load as well as future demand for electricity in the area. ***Landscape Dynamics Environmental Consultants*** has been appointed by Eskom Holdings Limited to undertake a Basic Assessment for the proposed substation.

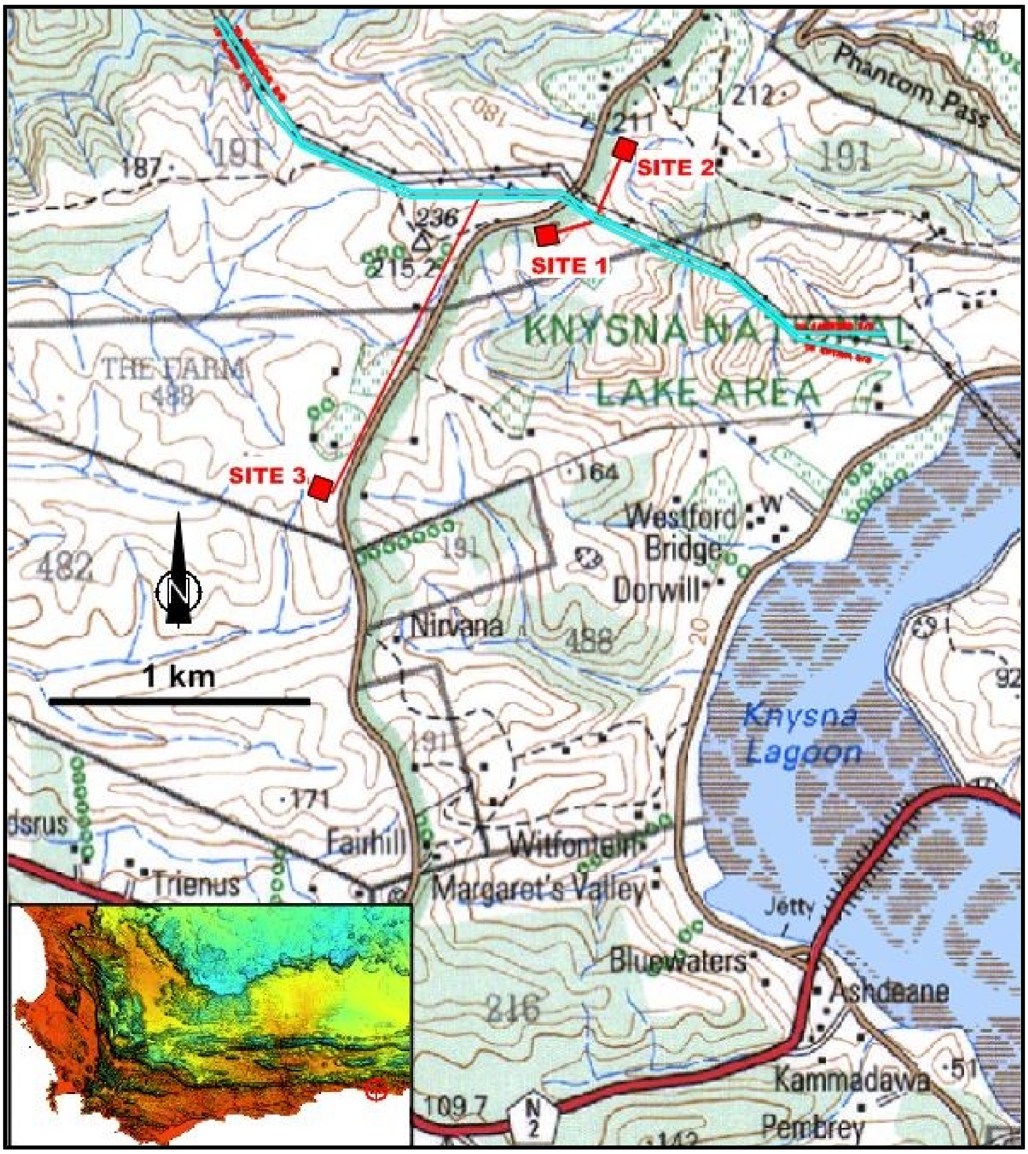


Figure 1. Alternative locations for the proposed new Eskom Phantom Substation (approx.). Extract from 3422BB_1998_ED3_GEO.TIF 1:50000 topo-cadastral sheet. Chief Directorate National Geo-spatial Information of South Africa. KMZ file kindly supplied by Landscape Dynamics.

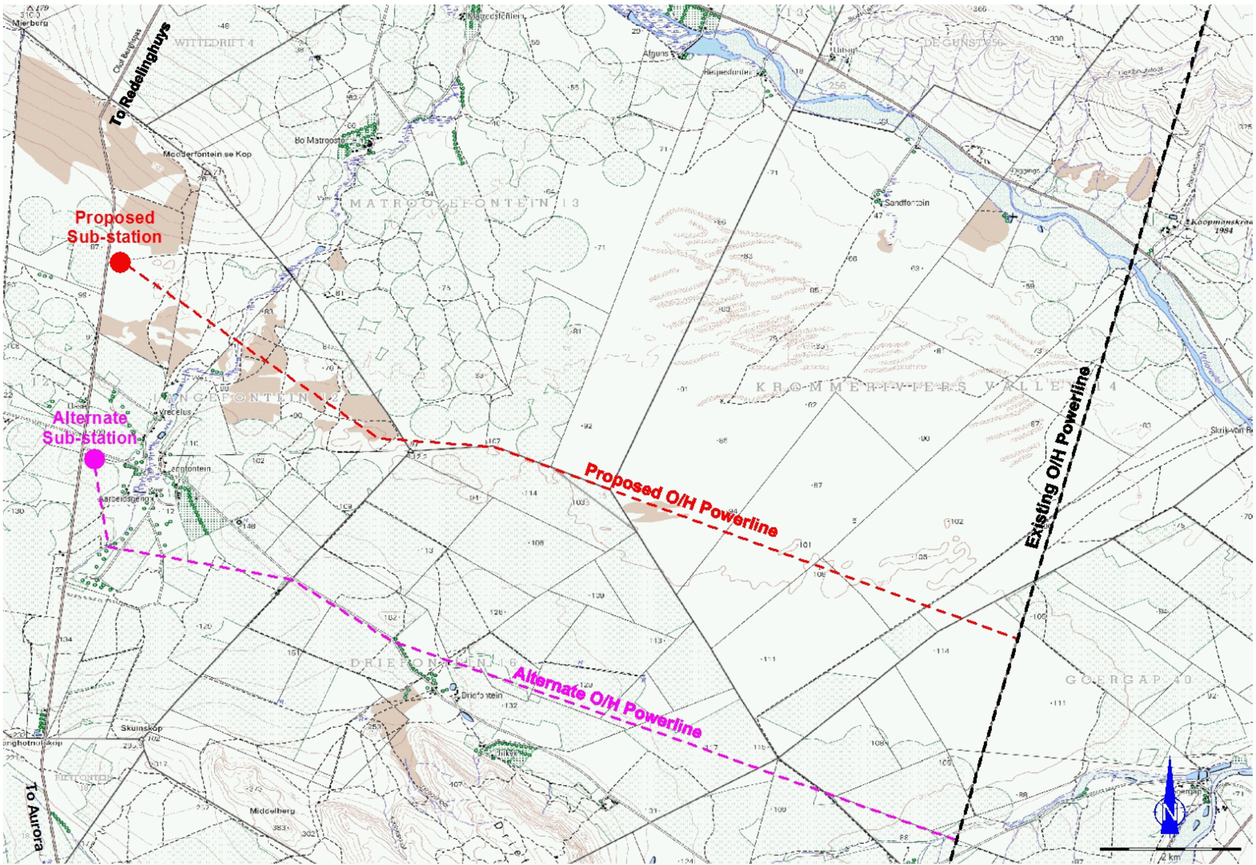
Three technically viable site alternatives with associated powerline routes have been identified by the Eskom engineers and will be assessed during the EIA process (Figure 1). The sites are situated relatively closely to each other next to the Rheenendal Road. The properties that are involved are Farm 191, Portions 44 and 45 (Sites 1 & 2) and the Remainder of Farm 488 (Site 3).

This Palaeontological Impact Assessment (PIA) is part of the Heritage Impact Assessment (HIA). Its subject is fossils and because fossils are usually found buried in the ground, palaeontological interventions mainly happen once fossil material is exposed at depth, *i.e*. once the EIA process is done, the project is approved and construction commences.

The purposes of this palaeontological assessment are to:

- Outline the nature of possible palaeontological/fossil heritage resources in the subsurface of the study area.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during bulk earth works.

The action plans and protocols for palaeontological mitigation must therefore be *included in the Environmental Management Plan (EMP) of the proposed project*. Appended to this PIA is a general fossil-finds procedure for the appropriate responses to the discovery of palaeontological materials during construction of the powerline footings and Phantom substation.



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 or 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 (Section 38). If the extent of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 m^2 (NHRA 25 (1999), Section 38 (1)), it must be assessed for heritage impacts that include assessment of potential palaeontological heritage (a PIA).

3 THRESHOLDS

The substation site typically involves an area of 60X75 m (4500 m^2), with an access servitude area of 95 m x 35 m (3325 m^2). The lengths of the linking powerlines applicable to each site, to the T-off from the existing powerline (Figure 1), are as follows:

- Site 1 – ~160 m.
- Site 2 –~260 m.
- Site 3 – ~1.3 km.

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern. The foundation slabs for the new substation are not expected to exceed 1 m in depth. The dimensions of the footings (foundations) for the powerline pylons are not specified in available information. The footings vary according to the size of the pylon and the geotechnical characteristics at each pylon site, with more substantial footings required in soft or yielding sands and soils. In this instance (see below) the sites are situated on coversands that generally are soft. Consequently footings may extend to ~3-4 m depth.

4 APPROACH AND METHODOLOGY

4.1 AVAILABLE INFORMATION

The point of departure is the geological map of the area *viz*. 1:125000 Geological Sheet 3322 OUDTSHOORN (Council for Geoscience, Pretoria, 1979). The relevant part of the geological map is reproduced as Figure 2. Since then, ongoing research has added various refinements of the geology and the map needs to be updated, but the map essential remain valid.

The information relevant to the geological and fossil record of the area is that concerning the Knysna Formation and the overlying coversands that mantle the older part of the coastal platform above about 120 m asl. in the Wilderness region. These later research contributions relevant to this assessment are cited in the normal manner as references in the text and are included in the References section. Due to extensive forest cover, most information has come from observations in local drainages, sand quarries, development earth works and eroded areas resulting from disturbance/removal of the binding vegetation.

4.2 ASSUMPTIONS AND LIMITATIONS

The assumption is that the fossil potential of the formations underlying a site will be typical of that found in the wider region. Scientifically important fossil material is expected to be very sparsely scattered in the coversand deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations.

A limitation on predictive capacity exists in that it is not possible to predict the buried fossil content of an area or formation other than in such general terms. Certain processes/agents can produce significant concentrations of fossil bones, but the possibility of these specific buried palaeoenvironments being present is only hinted at by the general setting of a site.

5 GEOLOGICAL AND PALAEONTOLOGICAL SETTING

5.1 THE GEOLOGY OF KNYSNA

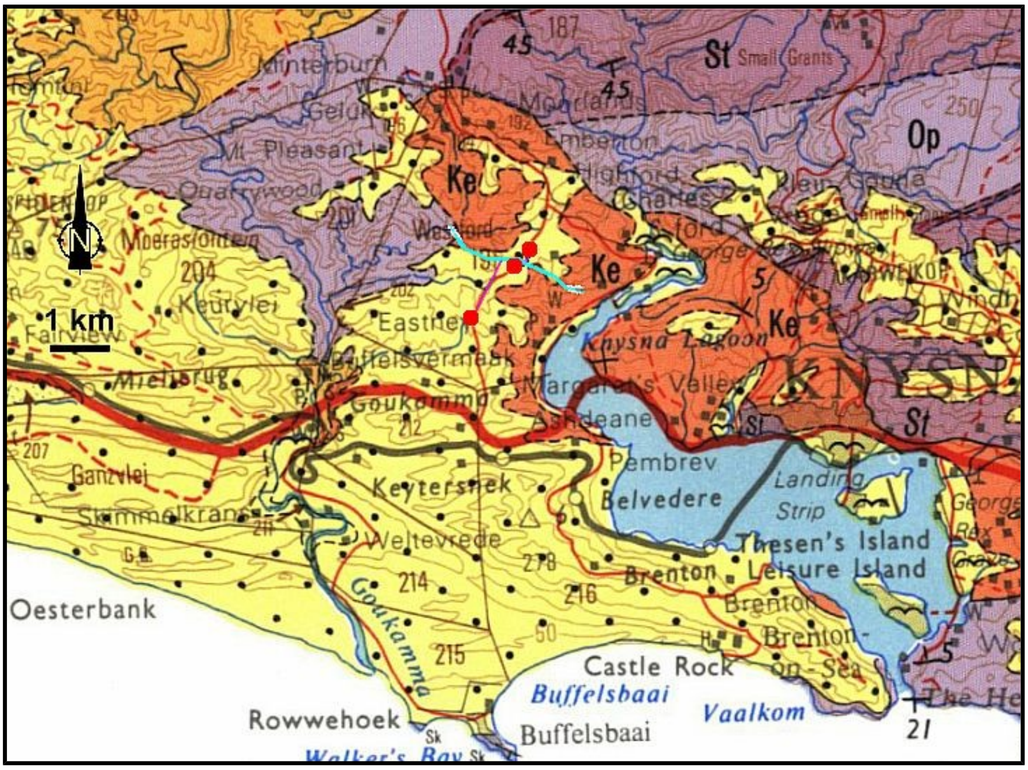


Figure 2. The geology of the area. Extract from 1:125000 Geological Sheet 3322 OUDTSHOORN. Sites = large red dots.

The sites are situated on the dissected and lowered edge of the "Coastal Platform" that forms the higher, older part of the coastal plain (Figure 3). This high "Coastal Platform" is considered to be the coastal manifestation of the old "African Surface", formed some time after the break up of the Gondwana supercontinent as Africa adjusted to its new margin seaboard, but now lifted up to its present altitude of between ~200-260 m asl. (Marker & Holmes, 2002). The elevation of Sites 1 and 2 is ~190 m asl., while Site 3 is ~170 m asl.

The "Coastal Platform" in this region is cut across Cape Supergroup rocks of the **Table Mountain Group** (TMG) sandstones and quartzites, deposited 470-400 Ma (Ordovician and Silurian periods) (purple hues in Figure 2). This bedrock comprises the **Peninsula Formation** (**Op**) and the **Goudini Formation** (**St**) (Figure 2) (on this map still labelled by its old, superseded name, the Tchando Fm).

Figure 3. Simulated oblique aerial view of the Knysna area, with geology overlay.

Another prominent unit, labelled **Ke** in Figure 2 (orange hue), also forms part of the high “Coastal Platform”. At lower elevations it also underlies the Knysna lagoon and it erosion away has formed the “Knysna Amphitheatre” feature of the present landscape, with cliffed exposures of these deposits along the northern shore of the lagoon. This geomorphology relates to the breakup of the supercontinent Gondwana during late Jurassic to early Cretaceous time, between about 155 Ma and 134 Ma. The crust south of the present-day coast subsided by faulting and detached, sliding away with South America where it is now the submerged Falkland Plateau.

The breakup landscape was rugged, with high areas forming long capes (horsts) between downfaulted segments (grabens) that formed steep-sided basins. These fault-bounded basins were then filled up with deposits of the **Uitenhage Group** (**Ke**). The initial basin-edge deposits are erosional debris from the Cape Supergroup highlands, deposited as talus and debouching alluvial fans and forming the coarse, conglomeratic **Enon Formation**. Farther downslope into the basin, these deposits interfinger with and are succeeded by fluvial deposits of the **Kirkwood Formation**, consisting of river-channel pebble gravels, sand bar sandstones and overbank muds. Still farther downslope at the new coast were deltas, estuaries and marine embayments. In the Algoa Basin/embayment (Port Elizabeth area) these mainly-marine sediments are called the **Sundays River Formation**. In the Knysna Basin, marine sediments with fossil shells are exposed along the western shore of the lagoon; the **Brenton Formation** (Figure 2).

The subsequent geological history of the region involves coastal-plain marine platform development and shallow-marine deposits that relate to periods of high sea level during the Cenozoic Era. In Figure 2 the high, old “Coastal Platform” can be seen in the background, now largely cultivated land. It dates back to the early Cenozoic (Paleogene) times. Definite marine deposits have not been found on the platform (Thwaites & Jacobs, 1989). However, the isolated preservation of Eocene marine deposits at high elevations in the Eastern Cape (Bathurst) and Namibia (Buntfeldschuh) suggests that it is likely that the high "Coastal Platform" was last occupied by the sea during Eocene times, between 55-34 Ma.

In the Knysna region, Marker (1987) has recorded marine benches below the high Coastal Platform, eroded at 120-140, 90, 60 and 30 m asl. This is in broad accord with the general sea level history preserved as actual marine formations elsewhere on the coast (*e.g*. De Hoopvlei and Alexandria formations). Marine deposits have been recognized in similar topography in the Plettenberg Bay area, relating to sea levels reaching ~100, ~60 and ~ 30 m asl. (Butzer & Helgren, 1972). These sea levels are very similar to those seen on the West Coast, where they are dated to ~16-15 Ma (late Early Miocene), ~5-4 Ma (early Pliocene) and 3.5-3.0 Ma (mid-Pliocene), respectively (Pether *et al*., 2000).

The marine deposits are overlain by aeolianites of varying thicknesses and ages. Most obvious in the landscape are the coast-parallel dune cordons below the high "Coastal Platform" – these have been dated by the OSL technique and have accumulated since mid Quaternary times ~240 ka (Bateman *et al*., 2010). The marine deposits and the overlying, young, calcareous aeolianites occur at elevations below the substation sites and are not of further concern here. Instead, the deposits preserved at higher elevations are of concern.

5.2 GEOLOGY AT THE SITES

On the geological map the aeolian sand mantle on the coastal plain is depicted in yellow with black dots (fixed dunes and dune rock) and is not differentiated (Figure 2). However, a basic distinction can be drawn between the younger, calcareous aeolianites at lower elevations and the decalcified, structureless, old sands that mantle the higher parts of the coastal plain. The latter have been referred to as the "**coversands**". These coversands have been investigated by Marker & Holmes (2002), Holmes *et al*. (2007) and Carr *et al*. (2010). Figure 4 shows their map of the distribution of *in situ* coversands and it shows a much more extensive distribution of these older coversands on the high "Coastal Platform" *cf*. the more limited distribution of obvious aeolianites shown on the Oudtshoorn geological sheet.

The *in situ* coversands are distinguished by their weathering and have well-developed pedogenic profiles, with clay formation, reddish, yellow and brown hues and may include lateritic pisoliths and "hardpans". These old coversands have also been extensively reworked and redeposited as soft yellowish sand colluvium on the dissected slopes surrounding the preserved "Coastal Platform". The sand mine near Site 3 shows yellow sand, consistent with reworked coversand, while the hue of soils on the "Coastal Platform" is reddish. The sites are below the +200 m asl. edge of the "Coastal Platform" and are thus most likely to be underlain by these reworked coversands. Dating of these sands by OSL and similar techniques indicates that they are >300 ka and were redeposited during the mid-Quaternary and also probably earlier.

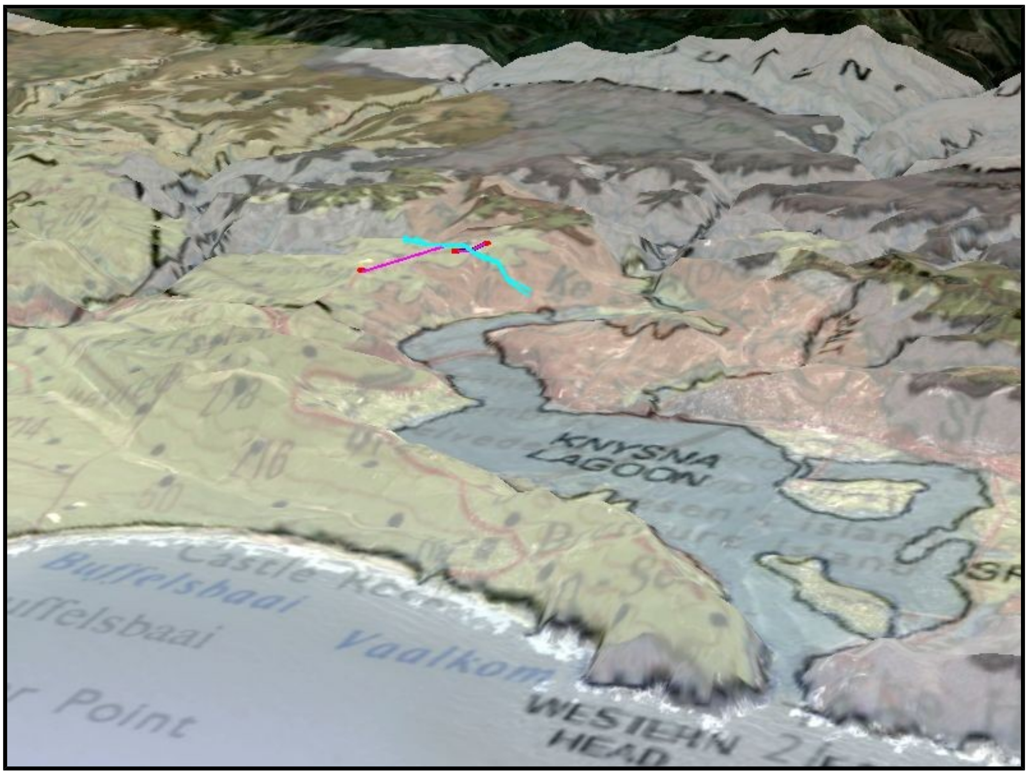
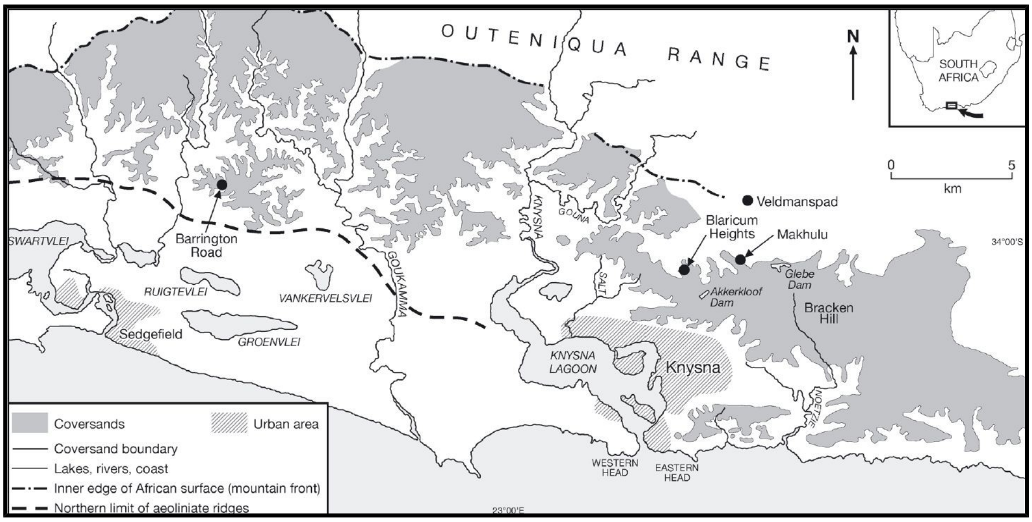


Figure 4. As Figure 3 with the distribution of in situ coversands superimposed (grey shading on the high "Coastal Platform" surface). From Holmes et al., (2007).

Beneath the coversands are the "**Knysna Lignites**", *viz*. coalified peat formed by the accumulation of vegetation. Thwaites & Jacobs (1987) reviewed the information about these deposits and Jacobs (1992) formally named the deposits the **Knysna Formation**. The main localities are Veldmanspad and Bracken Hill (Figures 5 & 6) and the lignite appears to occupy basins formed locally on the TMG surface. The origin and age of both the Coastal Platform and the Knysna Formation have been somewhat contentious, but a main view is that the Coastal Platform is probably of Eocene age, with the Knysna Formation being later Eocene or early Miocene.

New data from multidisciplinary studies of the lignite bed exposed at Makhulu Quarry sheds light on its origin (Carr *et al*., 2010). The lignite geochemistry indicates a fully-terrestrial setting (no marine influence) and the fossil pollen is dominated by an extinct palm type consistent with the lignite forming in a palm swamp. Yellowwood trees were present in the landscape and daisies, other herbaceous plants and grasses were present. Altogether the pollen assemblage precludes an age as old as Eocene and an age of mid-Miocene or younger is indicated. A thermoluminescence date on the overlying coversand indicates an minimum age of 1.7 Ma.

Figure 5. Locations of Knysna lignites and coversand sections – from Carr et al.,



2010.

Figure 6. The Knysna lignites exposed in a trench in the Veldmanspad area..

It may be that the spatially-separate occurrence of Knysna-type lignites are not all the same age, but reflect times of humid-climate episodes when the coastal plain was occupied by more tropical vegetation. The oldest lignites could have formed during high sea levels of the Mid-Miocene Climatic Optimum 16-14 Ma.

The extensive coversands show that at other times during the later Miocene and Pliocene aeolian activity characterised the coastal plain and the Knysna Afromontane Forest cover must have been substantially reduced. Continued reworking of the coversands by aeolian, colluvial and local fluvial processes occurred during the early and mid-Quaternary.

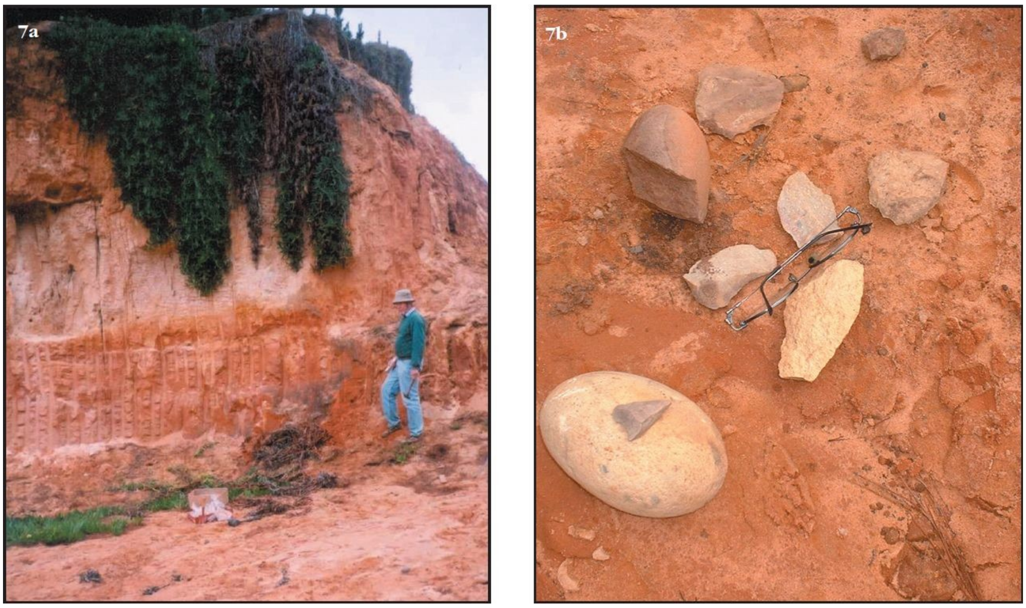


Figure 7. The exposure of coversand at Simola and ESA artefacts from its base. From Holmes et al., 2007.

5.3 *Expected Palaeontology*

The sites are situated on an interfluve just below the dissected edge of the “Coastal Platform”. They are likely to be underlain by reworked coversands. Hitherto no fossils have been recorded from the coversands, apparently due to their decalcification and pedogenic history.

Notably, Figure 2 in Marker & Homes (2002) shows coversand thickness of >3 m in the vicinity of Site 3, while closer to the edge of the “Coastal Platform” near Sites 1 and 2 a thickness of 6 m is indicated. Accepting these data, it seems unlikely that bulk earth works for the installations will be deep enough to encounter the underlying deposits of the Uitenhage Group such as the palaeontologically-sensitive Kirkwood Formation. In any event, an intersection of these strata is likely to be superficial and within its weathered profile that is unlikely to produce quality fossils.

Similarly, it seems unlikely that underlying Knysna Formation lignites will be encountered. Furthermore, all confirmed occurrences are above 200 m asl. on the preserved “Coastal Platform” surface.

Fossils do occur in aeolian sands, although usually very sporadically. Even in these altered sands it is possible that cryptic casts of dissolved fossils could occur, formed by sand infills and clay illuviation into the cavities left by fossils dissolving in the pedogenic profile. These will initially appear as curiously-shaped nodular objects, probably with ferruginous hues. Fossil teeth, due to their density, persist longer in the pedogenic profile, but due to small size are easily missed.

5.4 BURIED ARCHAEOLOGICAL MATERIAL

Importantly, archaeological material is quite common in the coversands. Early Stone Age (ESA) finds are associated with the "Brakkloof" sands around Plettenberg Bay (Butzer & Helgren, 1972). At Brakkloof the ESA artefacts were originally deposited on top of aeolianites near bedrock outcrop that provided the quartzite raw material for the implements. The aeolian sands were later redeposited by colluvial processes and the ESA material was reworked into the colluvial section (pers. obs.). A capping lateritic pedogenic profile developed later. Similarly, ESA artefacts have also been found in the coversands at Simola (~5 km west of Makhulu Quarry). The exposure at Simola (Figurre 7) showed ~4 m of laterized aeolianite with Acheulean (ESA) in the base of the section (Holmes *et al*., 2007). In view of the ~1 Ma duration of the ESA, it is not unexpected that ESA material may occur on top, within and below the reworked coversands of various ages in the landscape.

6 NATURE OF THE IMPACT OF BULK EARTH WORKS ON FOSSILS

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, provided that efforts are made to watch out for and rescue the fossils. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. The 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 dunes and 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 watching for them.

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.

7 RECOMMENDATIONS

All three sites occur on coversands and are not distinguished in terms of palaeontological sensitivity.

The coversands have low palaeontological sensitivity. Notwithstanding, there is a small possibility that a fortuitous fossil find may occur.

Sometimes the bones of large animals (elephant, buffalo, rhino) occur in coversands and dunes. Such could feasibly survive in some form in the pedogenic environment of the Knysna coversands. Fossils may also occur in an imperfectly preserved form such as concretions or nodules formed in cavities.

In contrast, ESA archaeological material is not uncommon.

It is recommended that the excavations and excavated material from the holes made for the foundations and pylon footings be monitored for the occurrence of archaeological material and possible fossils, particularly fossil bones/teeth. Appendices 1 and 2 outline monitoring by construction personnel and general Fossil Find Procedures.

The intersection of beds of black lignitic material should be reported (Knysna Formation), although deemed unlikely. Should Knysna lignite be uncovered, Peter Holmes will be interested.

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In the case of other potential fossil finds, the Manager/Environmental Officer must contact and inform the contracted palaeontologist. The palaeontologist will assess the information and liaise with the manager and the ESO and a suitable response will be established.

Stone Age (ESA) artefacts occur in the coversands. If uncovered, liaise with the contracted archaeologist.

In the event of a significant fossil occurrence, a professional palaeontologist must be appointed to supervise their excavation and to record their contexts. Said palaeontologist/sedimentologist must also undertake final inspections, the latter involving the recording of the stratigraphy and sedimentary geometry of the exposures and the compilation of the report to Heritage Western Cape and the IZIKO S.A. Museum.

7.1 MONITORING

Table 1. Basic measures for the Construction EMP

OBJECTIVE: To see and rescue fossil material that may be exposed in the various excavations made for pylon installation and substation foundations.	
Project components	Pylon footings & foundation excavations, 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.	ESKOM, Environmental Site Officer (ESO), contractors.	Pre-construction.
Inform staff of the procedures to be followed in the event of fossil occurrences.	ESO/palaeontology specialist.	Pre-construction.
Monitor for presence of fossils	Contractor personnel and ESO.	Construction.
Liaise on nature of potential finds and appropriate responses.	ESO and palaeontology specialist.	Construction.
Excavate main finds & record contexts.	Palaeontology specialist.	Construction.
Obtain permit from HWC for finds.	Palaeontology 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.	

It is probable that sparse, valuable fossil bones and other fossils will go undetected, even with the most diligent mitigation practicable. On the other hand, the finding and recovery of fossils will have a positive impact ranging from local to international in extent, depending on the nature of the finds

8 APPLICATION FOR A PALAEONTOLOGICAL PERMIT

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

A permit has not been applied for prior to the making of excavations. Should fossils be found that require rapid collecting, application for a retrospective palaeontological permit will be made to HWC immediately.

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

All fossil finds must be recorded and the fossils and their contextual information (a report) must be deposited at a SAHRA-approved institution.

9 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 supplied to the IZIKO S.A. Museum and Heritage Resources Western Cape. It must fulfil the reporting standards and data requirements of these bodies.

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

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11 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.

bsl: below (mean) sea level.

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.

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

EIA: Environmental Impact Assessment.

EMP: Environmental Management Plan.

ESO: Environmental Site Officer

Fluvial deposits: Sedimentary deposits consisting of material transported by water in suspension and by traction 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 disturbance or structure produced in sediments by organisms, such as burrows and trackways.

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.

Laterite: Soils in which iron oxides are concentrated and segregated in the form of mottling, nodules/pisoliths and cementation. Distinctive by various reddish, dark-brown to yellow-brown hues. The name laterite is derived from Latin - *later* = brick, which alludes to the brick-like hues. Also called plinthite (Greek *plinthos* = brick). Also known as ferricrete, iron pan, "ouklip" or "koffieklip", ngubane and murram. A warm, sub-humid to humid climate with a distinct dry season and a wet season is commonly associated with laterite formation. LSA: Late Stone Age. The archaeology of the last 20 000 years associated with fully modern people.

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".

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.

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.*).

Pedocrete: A duricrust formed by pedogenic processes.

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.

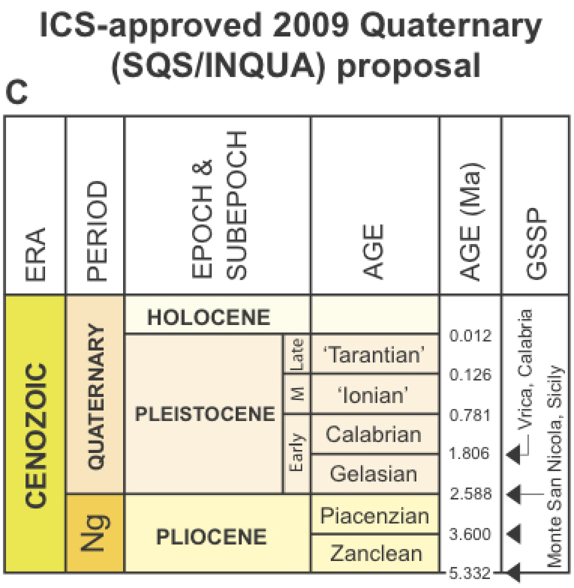
Type locality: The specific geographic locality where the stratotype of a layered stratigraphic unit is situated. The name also refers to the locality where the unit was originally described and/or named.

11.1 GEOLOGICAL TIME SCALE TERMS (YOUNGEST TO OLDEST).

See www.stratigraphy.org for more information.

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.

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).

12 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 Environmental Site Officer (ESO). The ESO 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 Site Officer (ESO) for the project.
- The Project Manager.

Should the monitoring of the excavations be a stipulation in the Archaeological Report, 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 Site Officer (ESO). If fossils are exposed in non-archaeological contexts, the palaeontologist should be summoned to document and sample/collect them.

Other alternatives could be considered, such as the employment of a dedicated monitor for the construction period.

12.1 CONTACTS FOR REPORTING OF FOSSIL FINDS.

West Coast Fossil Park

- Pippa Haarhoff: 083 289 6902, 022 766 1606, pippah@iafrica.com

Iziko Museums of Cape Town: SA Museum, 021 481 3800.

- Dr Romala Govender: 021 481 3895, 083 441 0028.

Heritage Western Cape

- Troy Smuts: 021 483 9543

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13 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 13.5).

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

13.1 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).

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 ESO must be informed.
- **Action 3:** The responsible field person (site foreman or ESO) 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:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of isolated bone finds

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

13.2 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.

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 ESO.
- **Action 3:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of a bone cluster find

The palaeontologist will assess the information and liaise with ESKOM 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. 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 a palaeontological context, the palaeontologist must evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

13.3 RESCUE EXCAVATION

Rescue Excavation refers to the removal of the material from 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.

13.4 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.

Management Options for Major Finds

In consultation with ESKOM 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.

13.5 EXPOSURE OF FOSSIL SHELL BEDS

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

- **Action 1:** The site foreman and ESO must be informed.

- **Action 2:** The responsible field person (site foreman or ESO) 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:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of fossil shell bed finds

The palaeontologist will assess the information and liaise with ESKOM 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.

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