HWC Case No. HWC23102704CH1031

PALAEONTOLOGICAL IMPACT ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT ON PORTION 36 OF FRANSCHE KRAAL 708 OVERSTRAND MUNICIPALITY, HERMANUS MAGISTERIAL DISTRICT, WESTERN CAPE

By

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Prepared at the Request of

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EXECUTIVE SUMMARY

1. Site Name

Proposed Residential Development on Portion 36 of the Farm Fransche Kraal 708.

2. Location

The site is approached via the R43 main road through Gansbaai to Franskraalstrand and is located adjacent to Uilenkraalsmond estuary (Figure 1).

3. Locality Plan

The Site Development Plan is presented in Figure 2.

4. Proposed Development

A low density residential development is proposed where most of the ~34 ha area remains as open space, with 55 erven, a clubhouse, walkways and two wetland areas. Instead of conventional building foundations in trenches it is proposed to use Self Drilling Anchor piles to support above-ground subframes for the dwellings, greatly reducing the sub-surface impact.

The services infrastructure for water, electricity and sewerage will be in conventional trenches about 1 m deep along the road reserves and connected to the municipal network.

Minor amendments of the layout of the SDP do not affect the recommendations of this PIA report.

5. Affected Formations

The site is underlain by bedrock of the Table Mountain Group **Peninsula Formation** quartzitic sandstones. This bedrock is mostly covered by a relatively thin mantle of coversands of mainly windblown origin which is not shown on the relevant geological map, but elsewhere where thicker is depicted as the **Qg coversands** (light grey to pale red sandy soil). Residual “raised beach” deposits of the Quaternary **Klein Brak Formation** may occur beneath the coversands. Close to the estuary in the southeastern corner of the property the coversands are underlain by the calcreted aeolianite of the late Quaternary **Waenhuiskrans Formation** (Figure 4).

6. Anticipated Impacts

The intensity or magnitude of impact relates to the palaeontological sensitivities of the affected formations (Appendix 1) and the volume of disturbance by excavation. Although the **Peninsula Fm**. bedrock is rated as HIGH by SAHRIS (Figure 9), for the most part its palaeontological sensitivity is LOW due to the sparse presence of the trace fossils and tectonic deformation which is particularly intense in the Southern Cape. An impact on the fossil heritage of the Peninsula Fm. from the proposed construction activities is not expected.

It appears that pre-existing deposits have been mostly eroded from the bedrock slope and it seems improbable that residual “raised beach” deposits of the **Klein Brak Fm**. with well-preserved fossil content are present. Due to the unfavourable setting a LOW sensitivity may be assigned to any residual Klein Brak Fm. raised beach deposits which may occur in the Project Area.

Intersection of the uppermost **Waenhuiskrans Fm**. in earthworks is limited (Figure 9), relative to the affected volume of overlying unconsolidated **Qg coversands** which mantle the area.

The overall, default palaeontological sensitivity of the Waenhuiskrans Fm. is classified as VERY HIGH and the unconsolidated Qg coversand deposits is classified as LOW by the SAHRIS Palaeo-Sensitivity map. Considering that the late Quaternary to present day faunas are fairly well known from archaeological sites and hyaena lair bone accumulations, additional finds are considered to be of moderate scientific importance, *i.e.* formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, may be assigned a MODERATE sensitivity rating (Appendix 1). These criteria apply to both the Qg coversands and the Waenhuiskrans Fm. Furthermore, although fossil bones are quite sparse in the older aeolianites and in the coversands, the ecologically diverse estuarine setting increases the probability that they could occur to distinctly possible. Buried archaeological material, such as artefacts, shell and bone scatters, and brown hyaena (strandwolf) bone stashes, could be uncovered in the coversands.

7. Recommendations

The possible presence of fossils in the subsurface does not have an a priori influence on the decision to proceed with the proposed development. The potential impact has a moderate influence upon the proposed project, consisting of implemented mitigation measures recommended below, to be followed during the Construction Phase.

It is not feasible for a specialist monitor to be continuously present during the Construction Phases, when fossil bones may be unearthed at any time. The rescue of fossil bones during earth works critically depends on spotting this material as it is uncovered during digging. For successful mitigation, it is therefore crucial that earth works personnel must be involved in mitigation by watching for fossil bones as excavations are being made. It is recommended that a protocol for finds of buried fossil bones, the Fossil Finds Procedure (FFP) (Appendix 3), is included in the Environmental Management Plan (EMP) for the proposed development.

The field supervisor/foreman and workers involved in excavations must be informed of the need to watch for fossil bones and archaeological material. Workers seeing potential objects are to cease work at that spot and to report to the works supervisor who, in turn, will report to the Environmental Control Officer (ECO) and/or the Developer. The ECO/Developer will contact and liaise with Heritage Western Cape and the standby palaeontologist on the nature of the find and suitable consequent actions such as immediate site inspection, application for a palaeontological collection permit and drafting of a work plan for the collection of the find.

A permit from HWC is required to excavate fossil bone finds. 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 palaeontological permit with supporting work plan will immediately be made to HWC. The application requires the details and permission of the registered owner of the site. The fossils and their contextual information must be deposited at a SAHRA/HWC-approved institution. The rescue of discovered palaeontological remains by a contracted specialist shall be at the Developer's expense.

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CONTENTS

COMPLIANCE WITH APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R326 (7 April 2017)	Addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	App. 5.
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	App. 4.
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.
(cA) an indication of the quality and age of base data used for the specialist report;	Sections 6 & 14.
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 9 - 12.
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 6.
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying alternatives;	Sections 9 & 10.
g) an identification of any areas to be avoided, including buffers;	N/A
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figures 2, 4 & 9.
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7.
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 9 & 12.
k) any mitigation measures for inclusion in the EMPr;	Section 13.
l) any conditions for inclusion in the environmental authorisation;	Section 13.
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 13 & App. 3.
n) a reasoned opinion- i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity and activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Sections 11 – 13.
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not Applicable
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not Applicable
q) any other information requested by the competent authority.	Not Applicable
2. Where a government notice gazetted by the Minister provides for any protocol of minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply	Site sensitivity verification requirements where a specialist assessment is required but no specific assessment protocol has been prescribed. See Appendix 1.

1 INTRODUCTION

The Developer/Owner, T. de Villiers, proposes to construct a residential development on Portion 36 of the Farm Fransche Kraal 708 near Franskraalstrand in the Overstrand Municpality (Figure 1). Lornay Environmental Consulting is undertaking the Environmental Impact Assessment (EIA) Assessment Report for the proposed development. ACRM has been appointed to undertake the Heritage Impact Assessment (HIA). This Palaeontological Assessment is part of the HIA and is to inform about the palaeontological sensitivities of the Project Area and the probability of fossils being uncovered in the subsurface and being disturbed or destroyed during the Construction Phase of the proposed development.

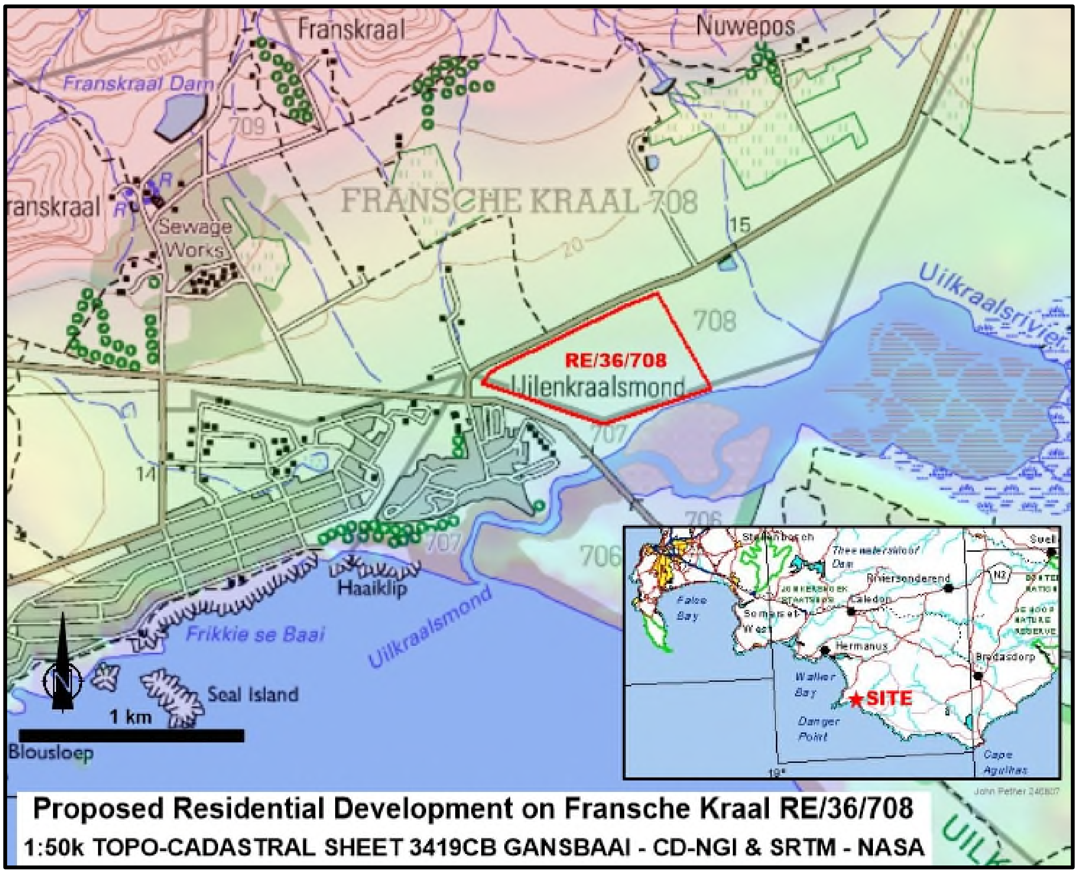

Figure 1. Location of the proposed development.

2 LOCATION

The proposed development site is approached via the R43 main road through Gansbaai to Franskraalstrand and is located adjacent to Uilenkraalsmond (Figure 1). The property extent is ~34 ha and is vacant land zoned as Agricultural.

Centre co-ordinates of proposed development area: -34.598934 °S / 19.415693 °E.

3 SITE DEVELOPMENT PLAN

The proposal is for a low density eco-type residential development where most of the surrounding area remains as vacant open space. The Site Development Plan for the proposed residences (Figure 2) entails 55 erven, a clubhouse, walkways and two wetland areas. Minor amendments of the layout of the SDP do not affect the recommendations of this PIA report.

Figure 2. Landscape setting and Site Development Plan of the Project Area. Post fire image showing the surficial coversands.

4 DESCRIPTION OF THE PROPOSED ACTIVITY

Instead of conventional building foundations consisting of trenches with concrete strip footings it is proposed to use Self Drilling Anchor piles as the foundation solution for the units (Figure 3). The piles are strategically placed to support the suspended subframe of the building , allowing the building to “float” just above the natural ground. This is much less intrusive than conventional foundations and uses a fraction of the amount of concrete as only a grout is pumped in around the anchors. A tracked rig is used to install the anchors.

The services infrastructure for water, electricity and sewerage will be in conventional trenches about 1 m deep along the road reserves and connected to the municipal network.

5 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. 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). If the areal scale of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 m^2 (0.5 ha) (NHRA 25 (1999), Section 38

(1)), the development must be assessed for heritage impacts (an HIA) that may include an assessment of palaeontological heritage (a PIA).

Figure 3. Self Drilling Anchor pile and installing rig. Courtesy Mike Hurworth, MH&A Consulting Engineers.

6 METHODOLOGY

As a desktop study, this report relies on the author's familiarity with the scientific literature pertaining to the geology and palaeontology of the coastal plains, together with own observations. The main geological information pertinent to the site is from Gresse & Theron (1992) and the relevant geological map (3319 Worcester), part of which is reproduced in Figure 4. Other sources include Malan *et al*. (1994) and Thamm & Johnson (2006). A general introduction to the younger Bredasdorp Group coastal plain deposits is Roberts *et al*. (2006). Additional relevant articles will be cited in the normal manner in the text and included in the References section.

In consultation with palaeontologists, the various geological formations/units are accorded a general or overall rating by the South African Heritage Resources Authority (SAHRA). Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit (Appendix 1). The sensitivity ratings are remapped on the 1:250 000 geological maps of South Africa and the resulting "Palaeo Map" is available on the SA Heritage Resources Information System (SAHRIS) website (https://sahris.org.za/map/palaeo).

Note that fossiliferous formations include a variety of fossils of differing scientific importance. For example, fossil shells are usually quite common, such as land snails in ancient dune rocks (aeolianites) and seashells in marine deposits (invertebrates), whereas the fossil bones of vertebrates (reptiles and mammals) are sparse and rare discoveries. Palaeontological sensitivity is based on the possibility of subsurface disturbance unearthing scientifically valuable fossils which, in the case of the formations of the coastal plains, fossil bones are the main concern.

7 GAPS, ASSUMPTIONS AND UNCERTAINTIES

The assumption is that the fossil potential of a formation in a Project Area will be typical of that found in the region and more specifically, similar to that already observed in the surrounds of the Project Area. In many cases the information on fossil content is limited to the basics, such as in the case of broad-scale geological mapping when the fossils are not the immediate focus. Scientifically important fossil bone material is expected to be sparsely scattered in coastal-plain deposits, but unless large and obvious, is not generally seen, under-estimating the fossil prevalence. Much depends on careful scrutiny of exposures and on spotting fossils as they are 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 general terms.

8 REGIONAL GEOLOGICAL SETTING

Figure 4. Geology of the Franskraalstrand area.

8.1 THE BEDROCK

The bedrock of the area is the **Peninsula Formation** of the **Table Mountain Group** (TMG) which is exposed along the shoreline and inland (Figure 5, Ope). The Peninsula Fm. is of early Ordovician age (490-470 Ma) (Ma = Mega-annum – million years ago) and is mainly comprised of fluvial quartzitic sandstones and conglomerates which were deposited by numerous braiding river courses that wandered across vast alluvial plains, unrestricted by the sediment binding of vegetated banks as land plants were only just beginning to appear. Hitherto only trace fossils (burrows and tracks) have been recorded from the Peninsula Formation.

8.2 THE BREDASDORP GROUP – COASTAL .PLAIN FORMATIONS

8.2.1 Mio-Pliocene De Hoopvlei Marine Formation

The Bredasdorp Group encompasses the Cenozoic deposits (younger than 66 Ma) which overlie the eroded surfaces of the aforementioned bedrock strata which were bevelled by marine erosion during transgressions by high sea levels. The associated marine deposits preserved in the southern Cape are the shelly calcareous sands and conglomerates of the **De Hoopvlei Formation**. The De Hoopvlei Formation is actually a composite “formation group” made up of marine formations of different ages which relate to periods of global warming which substantially melted polar ice and raised sea level. These are the Mid-Miocene Climatic Optimum ~16-15 Ma, the Early Pliocene Warm Period ~5-4 Ma and the Late Pliocene Warm Period ~3.0 Ma. The highest elevation marine deposits of the De Hoopvlei Fm. extend seawards from a highstand of sea level at ~110 m asl. and are of mid-Miocene age, those below ~60 m asl. are of early Pliocene age and marine deposits below ~30 m asl. are of late Pliocene age. The maximum palaeoshorelines altitudes attained are the result of a combination of the actual sea levels plus uplift of the subcontinent.

The late Pliocene shelly conglomerates of the De Hoopvlei Fm. are exposed in places along the cliffed coast, under the Waenhuiskrans cemented dunes (aeolianites), while inland the older deposits occur along valley flanks, beneath Wankoe Fm. aeolianites. The original thicknesses have been much reduced, mainly by wind erosion. An abundance of oyster shells distinguishes these older, warm-water deposits from the later Quaternary beach and estuarine deposits.

8.2.2 Mio-Pliocene Aeolianites

Subsequent to the marine inundations a huge pile of ancient dune sand has accumulated episodically on the coastal platforms, blown inland from the ancient sandy shorelines. These variously-cemented dunes (aeolianites) are much evident in the regional landscape west of Mossel Bay as old, calcrete-capped, rounded dune ridges (“Wankoe se Rante” or “Die Harde Duine”) and are particularly well displayed where erosion, road cuttings and limestone quarries reveal their internal, large-scale dune-slipface crossbedding.

The older aeolianites that cover the Mio-Pliocene De Hoopvlei Formation marine deposits are consigned to the **Wankoe Formation** which is also a composite. The maximum ages of these old aeolianites are the ages of the marine formations that underlie them and thus the Wankoe Formation aeolianites also become younger towards the coast. Aeolianites correlated with the Wankoe Fm. are not mapped in the Franskraal general area, but are found inland *e.g*. in the Bredasdorp area.

8.2.3 Quaternary Sea Levels and Raised Beaches

Since the end of the Pliocene Epoch ~2.6 Ma the Earth has been in the Quaternary Period, when there was a major expansion of the polar ice caps, mainly in the Northern Hemisphere. This was the onset of more marked, repetitive Ice Ages (glacials) when the expanded ice on continents subtracted water from the oceans and sea level rose and fell repeatedly. Sea levels fluctuated at positions mainly below the present level and down as much as ~130 m bsl. during glacial maxima (Figure 5), exposing much of the continental shelves (*e.g*. the Agulhas Bank) and increasing the width of the coastal plains for considerable time spans.

The colder, Ice Age palaeoclimates were interrupted by brief intervals of rapid global warming, called interglacials, of which the present time is an example, when sea levels were similar to the present level or just several metres above or below present level. Figure 5 shows the sawtooth pattern of sea-level and glacial/interglacial cycles of the last 800 ka (ka = thousand years ago) and the division into numbered Marine Isotope Stages (MIS based on the oxygen isotope ratios from deep-sea shelly microfossils, which reflects the global volume of water bound up as polar ice.

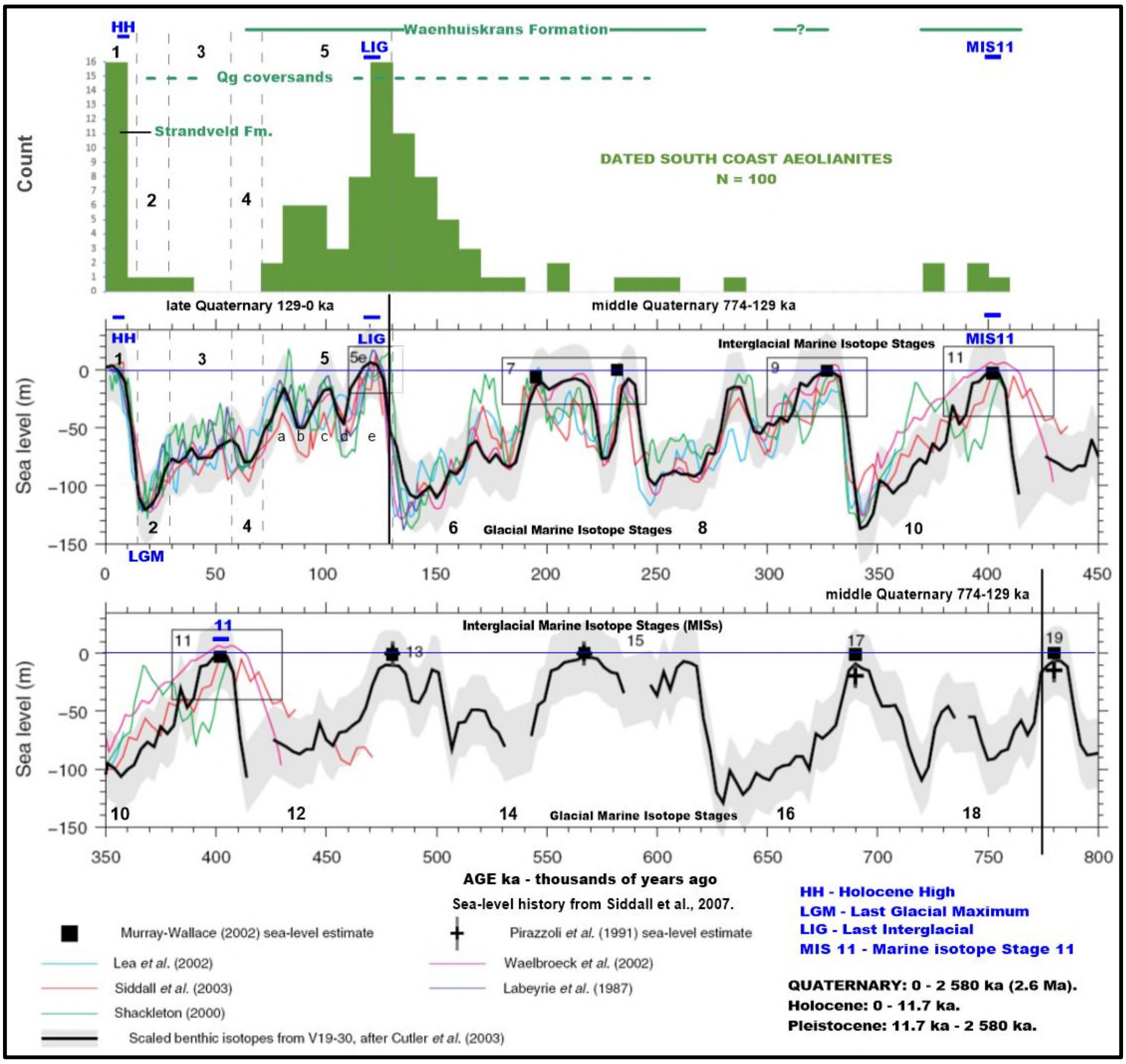

Figure 5. Sea-level history for the last 800 ka with numbered Marine Isotope Stages showing the ages of the Klein Brak Formation raised beaches and OSL dates from South Coast Waenhuiskrans Fm. aeolianites.

Sea levels higher than present occurred around 400 ka (MIS 11 - ~13 m asl.) and again about 125 ka (the Last Interglacial - ~6 m asl.) (Figure 5), leaving behind shallow-marine “raised beach” and estuarine deposits fringing the coast which are accommodated in the **Klein Brak Formation**. These high sea levels lapped onto older dunes and were later buried under younger dunes, embedding the raised beaches in notches in the coastal aeolianites.

Exposures of the Klein Brak Fm. are usually too small to be depicted at the scale of 1:250 000 geological maps. Many exposures of the Last Interglacial member of the Klein Brak Fm. occur along eroded coastal cliffs formed in the calcreted aeolianites of the Waenhuiskrans Fm., where the underlying marine exposures occur along the beach and in the intertidal zone.

8.2.4 Quaternary Aeolianites

During interglacial to intermediate shoreline levels dune plumes migrated onto the present-day coastal plain, sourced both from the raised beach shorelines and from now-submerged shorelines. These younger aeolianites comprise the **Waenhuiskrans Formation**, depicted as **Qw** (Figure 4) and so named after this place near Arniston where they form the low sea cliffs at the coast (Malan, 1989). Similar to the Wankoe Fm. aeolianites there is a calcrete-capped relict dune-ridge topography and internally the formation is comprised of “packages” of dune accumulation defined by separating reddish palaeosols and calcrete pedocretes.

The 100 OSL ages obtained from the Waenhuiskrans Fm. are shown in Figure 5 which indicates that aeolianites accumulated mainly since the glacial MIS 6 Ice Age ~170 ka, increased as the rising sea level approached the present coastline, to peak during the Last Interglacial +6 m sea level, and then to taper off as the sea level subsequently fell to below the present level and the shorelines became more remote from the present coastline.

Figure 6. Typical aspect of the Waenhuiskrans Formation exposed in a R319 road cutting where OSL ages of ~210 to 280 ka were obtained from sand samples at 1.5 and 2 m depth, resp.

In the Cape Agulhas area the sands beneath the calcrete capping in a road cutting on the R319 ~6 km north of Struisbaai produced ages of ~280 to ~210 ka (Bateman *et al*., 2004). The road cutting exposure of the formation at this location shows the typical capping calcrete, softer underlying sands with root casts (rhizoliths) and aeolian bedding (Figure 6). Closer to Cape Agulhas the crest of the aeolianite ridge dates to ~180-160 ka. Cliffed aeolianites at the coast near Stilbaai produced dates of ~140-90 ka (Roberts *et al*., 2008) and at Hoë Walle west of Cape Agulhas the aeolianites overlie the LIG Klein Brak Fm. and were deposited between ~104 to ~80 ka (Carr *et al*., 2010), *i.e*. during the later span of MIS 5 (Figure 5).

Reworked and redistributed **pale quartzitic coversands**, denoted **Qg**, mantle much of the wider coastal plain area, including covering much of the Waenhuiskrans Fm., although the Qg coversands are not depicted in Figure 4 in the area surrounding Franskraal. Near the coast the surficial coversands have been deposited subsequent to the LIG during the lower sea levels of the late Quaternary (Figure 5), when the "abandoned" near-coastal marine and dune sands were partly redistributed.

The latest addition of dunes to the coastal plain is the **Strandveld Formation** (Figure 4, **Qs**). These are loose, white, non-vegetated and vegetated dune sands blown from the beaches in the last several thousand years, during the Holocene (Figure 5), and accumulated in the form of a narrow dune cordon or "sand wall" parallel to the coast, or transgressing several kilometres inland as dune plumes, or formed across capes as headland bypass dune fields.

9 AFFECTED FORMATIONS

The Project Area is located on a wave-cut marine platform planed across the Peninsula Fm. quartzite bedrock, with surface topography sloping southwards from ~12 m asl. down to 2-3 m asl. Most of the area is mapped as the bedrock (Ope), with the strata dipping SE at 20º and which abuts an adjacent major fault bounding the Uilkraalsrivier estuary (Figure 4). The wider surrounding area is underlain by the calcreted Waenhuiskrans Fm. aeolianites (Qw). A small area of the Waenhuiskrans Fm. is mapped in the southeastern corner of the property where a steeper slope descends down to the edge of the estuary (Figures 2, 4). Recent dune sands of the Strandveld Fm. (Qs) are indicated around the estuary mouth, just lapping onto the lower southernmost part of the Project Area.

The area was occupied by the sea during the Late Pliocene Warm Period (~3 Ma), but other than residual rounded cobbles (Figure 7) it is unlikely that fossiliferous De Hoopvlei Fm. deposits remain. The high sea level of ~13 m asl. during MIS 11 (~400 ka) (Figure 5) would have inundated the Project Area. During the subsequent 270 thousand years the shoreline varied in distance from the site until sea level was exceeded again during the Last Interglacial and lapped onto the lower portion of the Project Area below about 6 m asl. However, no outcrops of the Klein Brak Fm. have been mentioned to occur around the Uilenkraalsmond estuary.

The fact that the bedrock is mapped beneath the Project Area implies that the quartzite strata are exposed in places and that overlying deposits are generally thin. The calcreted dune ridge topography typical of the Waenhuiskrans Fm. is not readily evident, due to the area being in the wind shadow of the Franskraal se Berge (Figure 8) and cut off from main sediment supply via the winter north-westerlies. Instead, the setting indicates that the Waenhuiskrans Fm. and the Strandveld Fm. sands are locally sourced from the Uilenkraalsmond beach by the summer southeasterlies. The Waenhuiskrans Fm. aeolianite at this location is of post-LIG age. The surficial cover of most of the general area, as seen in post-fire aerial images, would be classified as grey regic coversands (Qg), theoretically supporting Agulhas Sand Fynbos, but now seemingly covered with invasive rooikrans.

In summary, old residual marine gravels may occur on the quartzite bedrock of the Project Area and would have been reworked during the high sea levels of the mid and late Quaternary period. It is possible that patches of the Klein Brak Fm. "raised beach" or estuarine deposits may occur beneath coversands, but these have likely been subject to erosion by wind and subsequent pedogenic processes. The proposed development is mainly on the mapped bedrock and the surficial aeolian coversands (Qg) which mantle most of the Project Area. The Waenhuiskrans Fm. aeolianites in the low-elevation southeastern part of the Project Area are marginally affected, but the mapped boundaries are not necessarily precise.

Figure 7. Bedrock rubble and cobbles from shallow ditch of adjacent main road.

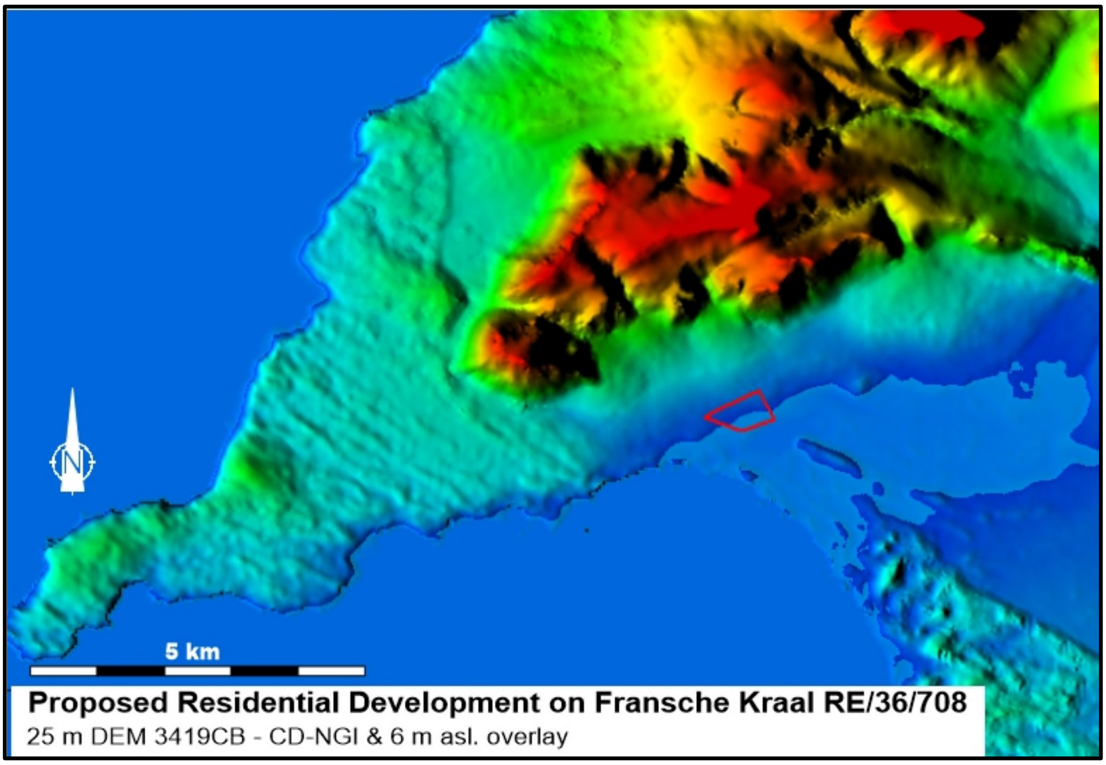

Figure 8. Dune ridges of the Waenhuiskrans Fm. and location of the Project Area in wind shadow, with topography flooded to 6 m asl.

10 ANTICIPATED IMPACTS ON PALAEONTOLOGICAL RESOURCES

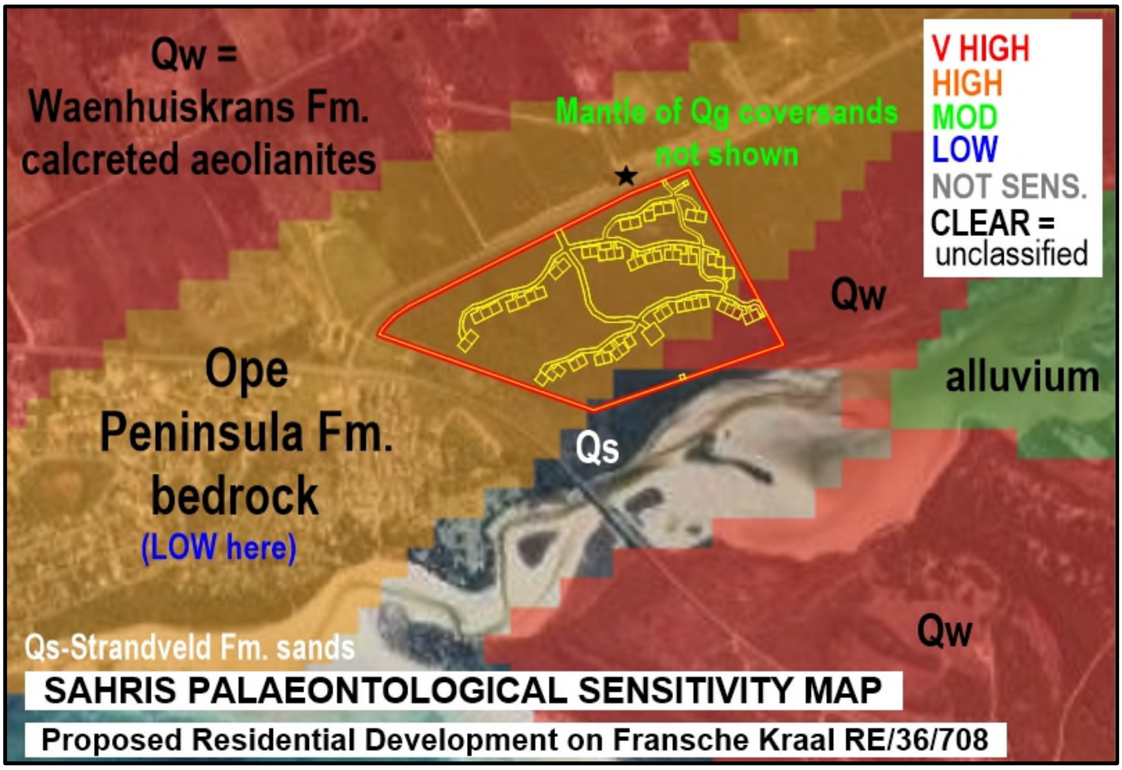

Figure 9. Palaeontological sensitivities of formations in the Uilenkraalsmond area. Star is location of Fig. 7.

Although the **Peninsula Fm**. bedrock is rated as HIGH by SAHRIS (Figure 9), for the most part its palaeontological sensitivity is LOW due to the sparse presence of the trace fossils which are also reasonably well-studied and which occur in rocks of similar Ordovician age globally (Almond & Pether, 2008, 2009). Furthermore, deformation during the up-thrusting of the Cape Fold Mountains was particularly intense in the Southern Cape zone and the mudrock beds with trace fossils were most affected by the deformation, as zones of shearing and shaley cleavage development, compromising the fossil content. An impact on the fossil heritage of the Peninsula Fm. from the proposed construction activities is not expected.

Marine deposits of the **De Hoopvlei Fm**. and the **Klein Brak Fm**. have apparently been eroded from the bedrock platform, although it is possible that residual deposits may be encountered in the trenches for services. Thin veneers of cemented De Hoopvlei Fm. conglomerates may occur, but the shell content in such cases is dissolved to moulds except for oyster shells.

The Klein Brak Fm. raised beach deposits include a fossil shell fauna which is mainly comprised of extant (living) species which are common today. In sheltered settings where warm-water conditions pertained locally the deposits may also include a few tropical species that no longer occur along the coast today, as well as a small number of extinct species. The development is above ~5 m asl. and may intersect the older, pre-LIG deposits wherein there is less potential for the preservation of fossil shells. Due to the unfavourable setting a LOW sensitivity may be assigned to any residual Klein Brak Fm. raised beach deposits which may occur in the Project Area.

Intersection of the uppermost **Waenhuiskrans Fm**. in earthworks is limited (Figure 9), relative to the affected volume of overlying unconsolidated **Qg coversands** which mantle the area.

The Waenhuiskrans Fm. in the Project Area is expected to be of earlier-late Quaternary age, post-dating the LIG sea-level highstand, between ~120 to ~80 ka (Figure 5). The pale Qg coversands close to the coast were distributed subsequently during the late Quaternary.

The fossil bones which occur in late Quaternary (129-0 ka) aeolian deposits are expected to be mainly species of the extant fauna. However, unexpected species and recently extinct species may occur, as a result of phases of different ecological and palaeoclimatic conditions during the Last Ice Age (MISs 5d to 2, Figure 5).

The overall, default palaeontological sensitivity of the Waenhuiskrans Fm. is classified as VERY HIGH and the unconsolidated Qg coversand deposits is classified as LOW by the SAHRIS Palaeo-Sensitivity map. Considering that the late Quaternary to present day faunas are fairly well known from archaeological sites and hyaena lair bone accumulations, additional finds are considered to be of moderate scientific importance, *i.e*. formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, may be assigned a MODERATE sensitivity rating (Appendix 1). These criteria apply to both the Qg coversands and the Waenhuiskrans Fm. Furthermore, although fossil bones are quite sparse in the older aeolianites and in the coversands, the ecologically diverse estuarine setting increases the probability that they could occur to distinctly possible. Buried archaeological material, such as artefacts, shell and bone scatters, and brown hyaena (strandwolf) bone stashes, could be uncovered in the coversands.

11 IMPACT ASSESSMENT

11.1 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 with respect to 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 deposits 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. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible. The very scarcity of fossils makes for the added importance of looking out 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.

This impact assessment, according to the rating scheme in Appendices 1 and 2, addresses the occurrence of the high-value fossil bones in the deposits.

11.2 EXTENTS

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance involved in the construction earthworks, *i.e.* LOCAL.

However, unlike an impact that has a defined spatial extent (*e.g.* loss of a portion of a habitat), the cultural, heritage and scientific impacts of fossil discoveries may be of regional to national extent, as is implicit in the National Heritage Resources Act No. 25 (1999) and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded palaeontological research that takes place in South Africa by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels.

11.3 Duration

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. The duration of impact is therefore LONG TERM and permanent with or without mitigation.

11.4 Intensity

The intensity or magnitude of impact relates to the palaeontological sensitivities of the affected formations (Appendix 1) and the volume of disturbance by excavation.

The use of Self Drilling Anchor piles to support dwellings considerably reduces the subsurface impact of the proposed development. The trenches for services infrastructure (generally ~1.0 m depth) and will primarily affect the aeolian Qg coversands and marginally affect the upper Waenhuiskrans Fm., of MODERATE palaeontological sensitivities with respect to fossil bones due to the estuarine shoreline setting.

Residual shelly deposits of the Quaternary Klein Brak Fm. may occur beneath the coversands, of LOW sensitivity due to the preponderance of extant species and previous sampling in the region. An impact on the fossil shell heritage of the Klein Brak Fm. is not expected.

11.5 Probability

In consideration of the shoreline setting of the proposed development it is considered probable (distinct possibility) that fossil bones and buried archaeological material are present within the Project Area.

11.6 Cumulative Impact

It will never be possible to spot and rescue all fossils which means that there will always be some loss and therefore cumulative negative impact. As mentioned, the impact of both the finding or the loss of fossils is permanent. The loss of fossils would be of unknown significance. Diligent and successful mitigation contributes to a positive cumulative impact as the rescued fossils are preserved and accumulated for scientific study. Positive impacts would continue to be felt with successful mitigation because of the scientific implications of the resulting research opportunities. Even though just a very minor portion of the bone fossils exposed in excavations has been seen and saved, the rescued fossils proved to be of fundamental scientific value.

12 SUMMARY IMPACT TABLE

IMPACT ON THE AEOLIAN COVERSANDS AND WAENHUISKRANS FORMATION

CONSTRUCTION PHASE	**Without Mitigation**	**With Mitigation**
Potential impact and risk:	Palaeontological heritage.	
Nature of impact:	Loss of fossil bones and archaeological material from excavations in the loose Qg coversands and upper Waenhuiskrans Fm.	
Extent and duration:	Site and permanent.	Regional to international and permanent.
Intensity/Sensitivity:	Moderate.	Moderate.
Consequence of impact or risk:	Permanent loss of material palaeontological heritage.	Permanent loss of material palaeontological heritage.
Probability of occurrence:	Probable, distinct possibility.	Probable, distinct possibility.
Degree to which the impact may cause irreplaceable loss of resources:	Complete loss of fossil resources.	Significant loss may still occur.
Degree to which the impact can be reversed:	Irreversible.	Irreversible.
Indirect impacts:	Impoverished landscape geohistory.	Enriched landscape geohistory.
Cumulative impact:	Permanent loss of fossils and the associated scientific implications.	Some fossils are rescued for posterity and available for scientific study.
Residual impact:	Permanent loss of fossils and the associated scientific implications.	Some fossils are rescued for posterity and available for scientific study.
SIGNIFICANCE RATING:	MEDIUM NEGATIVE.	MEDIUM TO HIGH POSITIVE.
Degree to which the impact can be avoided:	Low. The locations of fossil bones in the coversands and aeolianites cannot be predicted.	
Degree to which the impact can be managed:	Low. There is a high risk of valuable fossils being lost despite management actions to mitigate such loss.	
Degree to which the impact can be mitigated:	Moderate.	
Proposed mitigation:	• Construction personnel to be alert for rare fossil bones and follow "Fossil Finds Procedure". • Cease construction on discovery of fossil bones and protect fossils from further damage. • Contact appointed archaeologist/palaeontologist or HWC providing information and images. • The aforementioned will assess the information and establish suitable response, such as the importance of the find and measures for preservation, collection and record keeping. • Exposed fossiliferous sections in earthworks recorded and sampled by appointed specialist. • Fossils and their contextual information must be deposited at a SAHRA/HWC-approved institution.	

The ranking criteria are according to the scheme in Appendix 3.

	Extent	**Duration**	**Intensity**	**Status**	**Probability**	**Significance**	**Confidence**
Without mitigation	Local 1	Permanent 5	Med 6	Negative	Probable 3	Medium 36	M
With mitigation	Local 1	Permanent 5	Med 6	Positive	Probable 3	Medium 36	M

Without mitigation the significance of the impact is MEDIUM negative due to probable loss of fossil heritage, but the actual significance will not be known. The rescue of fossil bones from loss will have a positive outcome and, depending on the scientific importance of the find, may result in an impact of MEDIUM to HIGH significance.

13 RECOMMENDATIONS

The possible presence of fossils in the subsurface does not have an *a priori* influence on the decision to proceed with the proposed development. However, mitigation measures are essential. The potential impact has a moderate influence upon the proposed project, consisting of implemented mitigation measures recommended below, to be followed during the Construction Phase.

It is not feasible for a specialist monitor to be continuously present during the Construction Phases, when fossils may be unearthed at any time. The rescue of fossil bones during earth works critically depends on spotting this material as it is uncovered during digging.

For successful mitigation, it is therefore crucial that earth works personnel must be involved in mitigation by watching for fossils as excavations are being made.

It is recommended that a protocol for finds of buried fossil bones, the Fossil Finds Procedure (FFP), is included in the Environmental Management Plan (EMP) for the proposed development.

The Fossil Finds Procedure included as Appendix 3 provides guidelines to be followed in the event of fossil bone finds in the excavations. The works supervisor/foreman and workers involved in excavating the infrastructure trenches and stormwater drainage must be informed of the need to watch for fossils and archaeological material. Workers seeing potential objects are to cease work at that spot and to report to the Works Supervisor who, in turn, will report to the Environmental Control Officer (ECO) and/or the Developer. The ECO/Developer will contact and liaise with Heritage Western Cape and the standby palaeontologist on the nature of the find and suitable consequent actions such as immediate site inspection, application for a palaeontological collection permit and drafting of a work plan for the collection of the find.

If a significant occurrence of fossil bones in a palaeontological context is discovered a professional palaeontologist must be appointed to collect them and to record their contexts. Said palaeontologist must also undertake the recording of the stratigraphic context and sedimentary geometry of the exposure, the sampling of ambient small fossil content and the compilation of the report for distribution to Heritage Western Cape, SAHRA, the approved curatorial institution and local heritage interest groups.

A permit from HWC is required to excavate fossil bone finds. 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 palaeontological permit with supporting work plan will immediately be made to HWC. The application requires the details and permission of the registered owner of the site. The fossils and their contextual information must be deposited at a SAHRA/HWC-approved institution. The rescue of discovered palaeontological remains by a contracted specialist shall be at the Developer’s expense.

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15 APPENDIX 1. PALAEONTOLOGICAL SENSITIVITY RATING

Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit.

VERY HIGH: Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.

HIGH: Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

MODERATE/MEDIUM: Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

LOW: Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

MARGINAL: Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the meta sedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

NO POTENTIAL: Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

Adapted from Society of Vertebrate Paleontology. 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin, Vol. 163, p. 22-27.

16 APPENDIX 2. METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

EFFECT	**Extents/Spatial Scale**		**E**
	Localized	At localized scale and a few hectares in extent.	1
	Study area	The proposed site and its immediate environs.	2
	Regional	District and Provincial level.	3
	National	Country.	4
	International	Internationally.	5
	Duration/Temporal Scale		**D**
	Very short	Less than 1 year.	1
	Short term	Between 2 to 5 years.	2
	Medium term	Between 5 and 15 years.	3
	Long term	Exceeding 15 years and from a human perspective almost permanent.	4
	Permanent	Resulting in a permanent and lasting change.	5
	Magnitude/Intensity (Palaeontological Sensitivity)		**M**
	No potential	Formations entirely lacking fossils such as igneous rocks.	0
	Marginal	Limited probability for producing fossils from certain contexts at localized outcrops.	2
	Low	Depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains.	4
	Medium	Strong potential to yield fossil remains based on stratigraphy and/or geomorphologic setting.	6
	High	Formations known to contain palaeontological resources that include rare, well-preserved fossil materials.	8
	Very high	Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.	10
	Probability/Likelihood		**P**
	Very improbable	Probably will not happen.	1
	Improbable	Some possibility, but low likelihood.	2
	Probable	Distinct possibility of these impacts occurring.	3
	Highly probable	The impact is most likely to occur.	4
	Definite	The impact will definitely occur regardless of prevention measures.	5

SIGNIFICANCE = (E+D+M) x P		
< 30	LOW	The impact would not have a direct influence on the decision to develop in the area
30-60	MEDIUM	The impact could influence the decision to develop in the area unless it is effectively mitigated
>60	HIGH	The impact must have an influence on the decision process to develop in the area

17 APPENDIX 3. FOSSIL FINDS PROCEDURE

17.1 MONITORING

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

The field supervisor/site 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 Works 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. These may include:

- The Works Supervisor/Site Foreman, who is going to be most often on site.
- The Environmental Control Officer (ECO) for the project.
- The Project Manager/Site Agent.

17.2 RESPONSE BY PERSONNEL IN THE EVENT OF FOSSIL BONE FINDS

The most important fossils of concern are the fossil bones and teeth of land animals.

In the process of digging the excavations fossil bones may be spotted in the hole sides or bottom, or as they appear in excavated material on the spoil heap, such as in chunks of calcrete and aeolianite.

- Stop work at fossil find. The site foreman and ECO must be informed.
- Protect the find site from further disturbance and safeguard all fossil material in danger of being lost such as in the excavator bucket and scattered in the spoil heap. Fossil bone-bearing chunks of calcrete can be stockpiled in a safe location.
- The ECO or site agent must immediately inform the monitoring archaeologist who will liaise with Heritage Western Cape (HWC) and the contracted standby palaeontologist on the nature of the find and provide via email the information about the find, as detailed below.
    - Date
    - Position of the excavation (GPS) and depth.
    - A description of the nature of the find.
    - Digital images of the excavation showing vertical sections (sides) and the position of the find showing its depth/location in the excavation.
    - A reference scale must be included in the images (tape measure, ranging rod, or object of recorded dimensions).
    - Close-up, detailed images of the find (with scale included).

The Heritage Western Cape (HWC) and/or the contracted standby palaeontologist will assess the information and a suitable response will be established which will be reported to the developer and the ECO, such as whether rescue excavation or rescue collection by a palaeontologist is necessary or not.

The response time/scheduling of the rescue fieldwork is to be decided in consultation with developer/owner and the ECO. It will probably be feasible to “leapfrog” the find and continue excavation farther along, so that the work schedule and machine time are minimally disrupted. The strategy is to rescue the material as quickly as possible.

17.3 RESPONSE BY PERSONNEL IN THE EVENT OF INTERSECTION OF FOSSIL SHELL BEDS

The site foreman and ECO must be informed.

The ECO or site agent must inform the standby palaeontologist and/or HWC and provide via email the information about the find, as detailed above:

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

If the shell bed is likely to be covered up again within a short time interval, such as by backfilling, a generous quantity (~1 m^3) of the excavated shell bed containing the fossils should be stockpiled at a suitable location, for later examination and sampling.

17.4 APPLICATION FOR A PERMIT TO COLLECT FOSSILS

A permit from HWC and a Work Plan 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 palaeontological permit must be made to HWC immediately. The application requires the details and permission of the registered owner of the site. The fossils and their contextual information must be deposited at a SAHRA/HWC-approved institution. The rescue of discovered palaeontological remains by a contracted specialist shall be at the Developer's expense.

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18 APPENDIX 4. DECLARATION OF INDEPENDENCE

HWC Case No. HWC23102704CH1031

PALAEONTOLOGICAL IMPACT ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT ON PORTION 36 OF FRANSCHE KRAAL 708

OVERSTRAND MUNICIPALITY, HERMANUS MAGISTERIAL DISTRICT, WESTERN CAPE

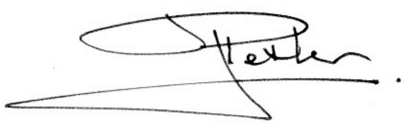
Terms of Reference

This assessment forms part of the Heritage Assessment and it assesses the overall palaeontological (fossil) sensitivities of formations underlying the Project Area.

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, 2014 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, 2014 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 48 of the 2014 NEMA EIA Regulations.



Signature of the specialist

Date: 20 August 2024

19 APPENDIX 5. CURRICULUM VITAE

John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)

Independent Consultant/Researcher recognized as an authority with 44 years' experience in the field of coastal-plain and continental-shelf palaeoenvironments, fossils and stratigraphy, mainly involving the West Coast/Shelf of southern Africa. Has been previously employed in academia (South African Museum) and industry (Trans Hex, De Beers Marine). At present an important involvement is in Palaeontological Impact Assessments (PIAs) and mitigation projects in terms of the National Heritage Resources Act 25 (1999) (~400 PIA reports to date) and is an accredited member of the Association of Professional Heritage Practitioners (APHP). Continues to be involved as consultant to offshore and onshore marine diamond exploration ventures. Expertise includes:

- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures, on/offshore cores and exploration drilling).
- Sedimentology and palaeoenvironmental interpretation of shallow marine, aeolian and other terrestrial surficial deposits.
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods) and biostratigraphy.
- 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.
- Association of Professional Heritage Practitioners (APHP), Western Cape. Accredited Member No. 48.

Past Clients Palaeontological Assessments

AECOM SA (Pty) Ltd.	Guillaume Nel Environmental Management Consultants.
Agency for Cultural Resource Management (ACRM).	Klomp Group.
AMATHEMBA Environmental.	Megan Anderson, Landscape Architect.
Anél Blignaut Environmental Consultants.	Ninham Shand (Pty) Ltd.
Arcus Gibb (Pty) Ltd.	PD Naidoo & Associates (Pty) Ltd.
ASHA Consulting (Pty) Ltd.	Perception Environmental Planning.
Aurecon SA (Pty) Ltd.	PHS Consulting.
BKS (Pty) Ltd. Engineering and Management.	Resource Management Services.
Bridgette O'Donoghue Heritage Consultant.	Robin Ellis, Heritage Impact Assessor.
Cape Archaeology, Dr Mary Patrick.	Savannah Environmental (Pty) Ltd.
Cape EAPrac (Cape Environmental Assessment Practitioners).	Sharples Environmental Services cc
CCA Environmental (Pty) Ltd.	Site Plan Consulting (Pty) Ltd.
Centre for Heritage & Archaeological Resource Management (CHARM).	SRK Consulting (South Africa) (Pty) Ltd.
Chand Environmental Consultants.	Strategic Environmental Focus (Pty) Ltd.
CK Rumboll & Partners.	UCT Archaeology Contracts Office (ACO).
CNdV Africa	UCT Environmental Evaluation Unit
CSIR - Environmental Management Services.	Urban Dynamics.
Digby Wells & Associates (Pty) Ltd.	Van Zyl Environmental Consultants
Enviro Logic	Western Cape Environmental Consultants (Pty) Ltd, t/a ENVIRO DINAMIK.
Environmental Resources Management SA (ERM).	Wethu Investment Group Ltd.
Greenmined Environmental	Withers Environmental Consultants.

Stratigraphic consulting including palaeontology

Afri-Can Marine Minerals Corp	Council for Geoscience
De Beers Marine (SA) Pty Ltd.	De Beers Namaqualand Mines.
Geological Survey Namibia	IZIKO South African Museum.
Namakwa Sands (Pty) Ltd	NAMDEB

20 APPENDIX 6. 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.

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

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, such as shells and shell fragments.

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.

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.

Conglomerate: A cemented gravel deposit.

Coversands: Aeolian blanket deposits of sandsheets and smaller dunes.

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

Fm.: Formation.

Fossil: The remains of parts of animals and plants found in sedimentary deposits. Most commonly hard parts such as bones, teeth and shells which in lithified sedimentary rocks are usually altered by petrification (mineralization). Also impressions and mineral films in fine-grained sediments that preserve indications of soft parts. Fossils plants include coals, petrified wood and leaf impressions, as well as microscopic pollen and spores. Marine sediments contain a host of microfossils that reflect the plankton of the past and provide records of ocean changes. Nowadays also includes molecular fossils such as DNA and biogeochemicals such as oils and waxes.

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).

MIS: Marine isotope stages (MIS), marine oxygen-isotope stages, or oxygen isotope stages (OIS), are alternating warm and cool periods in the Earth's paleoclimate, deduced from oxygen isotope data reflecting changes in temperature derived from data from deep sea core samples. Working backwards from the present, MIS 1 in the scale, stages with even numbers representing cold glacial periods, while the odd-numbered stages represent warm interglacial intervals (see Figure 7).

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 formed on a palaeosurface. The soil 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.

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.

Rhizolith: Fossil root. Most commonly formed by pedogenic carbonate deposition around the root and developed in palaeosols.

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

Stratotype locality: The place where deposits regarded as defining the characteristics of a particular geological formation occur.

Tectonic: Relating to the structure of the earth's crust and the large-scale processes which take place within it (faulting and earthquakes, crustal uplift or subsidence.

Trace fossil: A structure or impression in sediments that preserves the behaviour of an organism, such as burrows, borings and nests, feeding traces (sediment processing), farming structures for bacteria and fungi, locomotion burrows and trackways and traces of predation on hard parts (tooth marks on bones, borings into shells by predatory gastropods and octopuses).

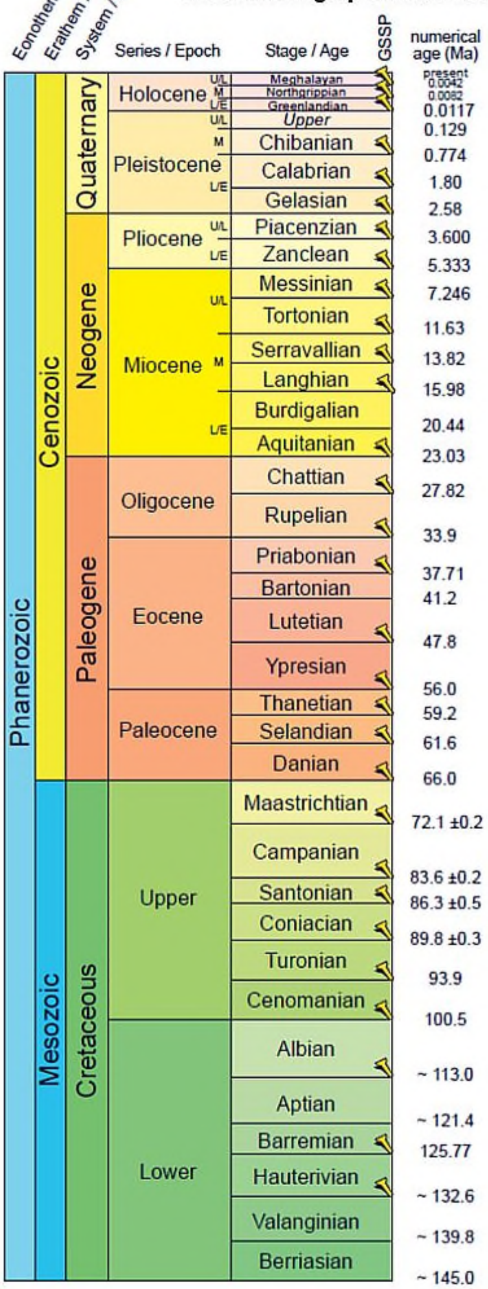
GEOLOGICAL TIME SCALE TERMS

For more detail see www.stratigraphy.org.

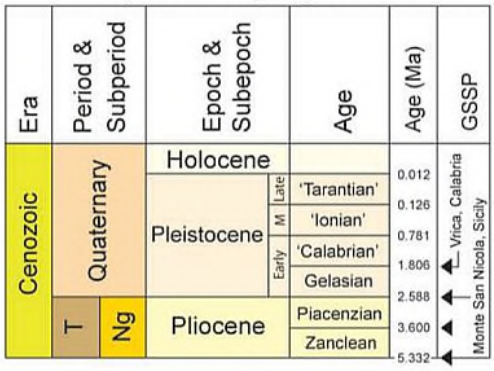
ka: Thousand years or kilo-annum (10^3 years). Implicitly means “ka ago” *i.e*. duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Not used for durations not extending from the Present. For a duration only “kyr” is used.

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. Not used for durations not extending from the Present. For a duration only “Myr” is used.

Mesozoic and Cenozoic Chronostratigraphy
From: International Commission on Stratigraphy.
Chronostratigraphic Chart 2023/06.pdf



ICS-approved 2009 Quaternary (SQS/INQHA) Proposal



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.

Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era.
The Quaternary includes both the Pleistocene and Holocene epochs. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.

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