# PALAEONTOLOGICAL IMPACT ASSESSMENT

## PROPOSED SEAFRONT DEVELOPMENT ON A PORTION OF PAAPEKUIL FONTEIN RE/281

## MARINE DRIVE, STRUISBAAI, CAPE AGULHAS MUNICIPALITY

## BREDASDORP MAGISTERIAL DISTRICT, WESTERN CAPE

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## EXECUTIVE SUMMARY

### 1. Site Name

Proposed Seafront Development on a Portion of Paapekuil Fontein RE/281, Marine Drive, Struisbaai, by Helemika Number 1 (Pty) Ltd.

### 2. Location

The proposed Seafront development site is located between the villages of Struisbaai and Cape Agulhas (Figures 1, 2 & 3) and is situated below a bend in Marine Drive known as the "Spookdraai".

### 3. Locality Plan

The Site Development Plan is presented in Figure 4.

### 4. Proposed Development

The proposed development entails 5 residential erven with a total area of 3277 $m^2$, situated on the slope above high water mark and below Marine Drive (Figure 4).

### 5. Affected Formations Identified

The wave-eroded bedrock quartzites of the **Peninsula Formation**. underlie the proposed development (Figure 5). The overlying deposits are not very thick and are expected to include raised beach deposits of the **Klein Brak Fm**. and windblown sands of the **Strandveld Fm**.

The Holocene High (~3 m asl., about 7 ka) would have impinged on the Project Area strip which very likely was inundated during storm surges, with deposition of "stormbeach" deposits above the highwater mark. Reworked marine sands of the aeolian Strandveld Fm. occupy the surface.

### 6. Anticipated Impacts

The palaeontological sensitivity of the Peninsula Fm. bedrock is rated HIGH (Figure 8), but the proposed small development is not expected to significantly impact the trace fossil content which might be preserved in the folded and deformed strata beneath the surficial sands.

The Klein Brak Fm. raised beach deposits typically consist of shelly sands and rounded gravels. In open-coast settings these Quaternary "raised beach" deposits include a fossil shell fauna which is mainly comprised of extant (living) species which are common today and which are not palaeontologically sensitive. In addition to fossil shells, scattered fossil bones such as from whales, dolphins, seals and seabirds may occur in the deposits, but are generally very rare. These are not likely to be extinct species, but species beyond their modern-day ranges may occur. A LOW sensitivity may be assigned to the raised beach deposits.

The marine sands have been eroded and wind-reworked to form a thin coversand equivalent to the Strandveld Fm. Fossil material such as marine shells and bones in these sands are likely to be in an archaeological context. Any "subfossil" bones are expected to be of the extant fauna and a LOW sensitivity may be assigned to the aeolian coversands.

Note that the prime concern is for land and marine animal bones and archaeological material.

### 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 Phases.

Although the inspection of construction excavations may be specified in the Archaeological Impact Assessment, 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 2), 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 archaeologist or 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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## 1 INTRODUCTION

The Applicant, Helemika Number 1 (Pty) Ltd., proposes to construct a residential development on Erf 3495 near Struisbaai in the Bredasdorp District (Figure 1). Lornay Environmental Consulting is undertaking the Environmental Impact Assessment (EIA) Basic Assessment Report for the proposed development. Cindy Postlethwayt has been appointed to undertake the Heritage Impact Assessment (HIA). This Palaeontological Assessment 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.

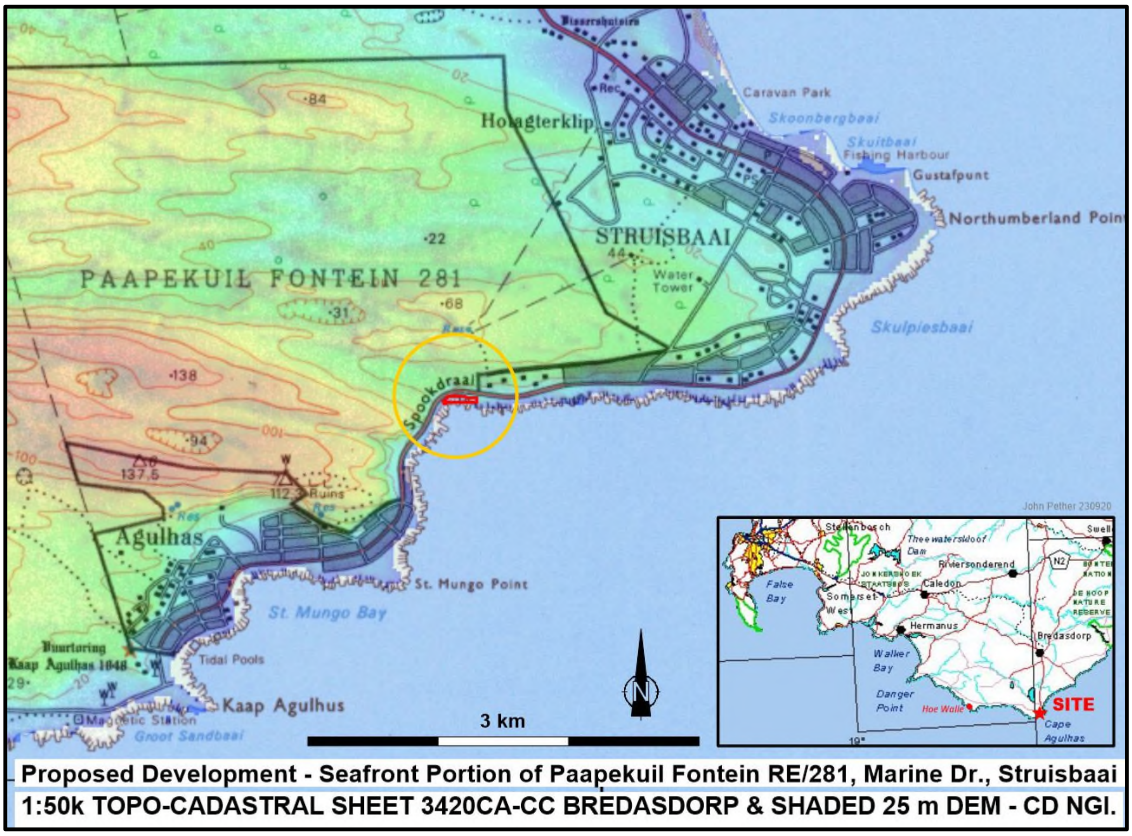


**Figure 1. Location of the proposed Seafront development.**

## 2 LOCATION

The proposed Seafront development site is located between the villages of Struisbaai and Cape Agulhas (Figure 1) adjacent to the R319 Main Road, which where it skirts the coast is locally called the Marine Drive (Figures 2 & 3), and is situated below a bend in the road known as the “Spookdraai” (Figure 1).

Centre co-ordinates of development area: -34.813702 °S / 20.031480 °E.

## 3 SITE DEVELOPMENT PLAN

The Site Development Plan for the proposed residences is presented in Figure 4. Minor amendments of the layout of the SDP do not affect the recommendations of this PIA report.


**Figure 2. Landscape setting of the proposed Seafront Project Area.**

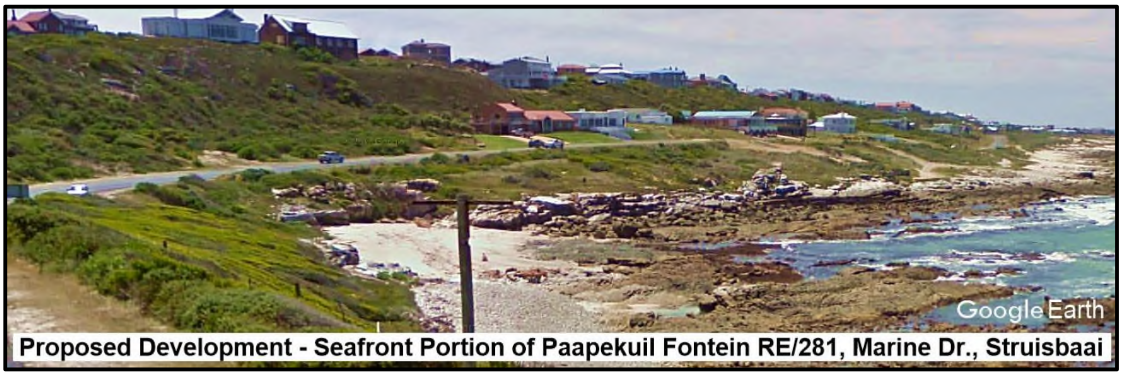


**Figure 3. Street view of the proposed Seafront Project Area.**

## 4 DESCRIPTION OF THE PROPOSED ACTIVITY

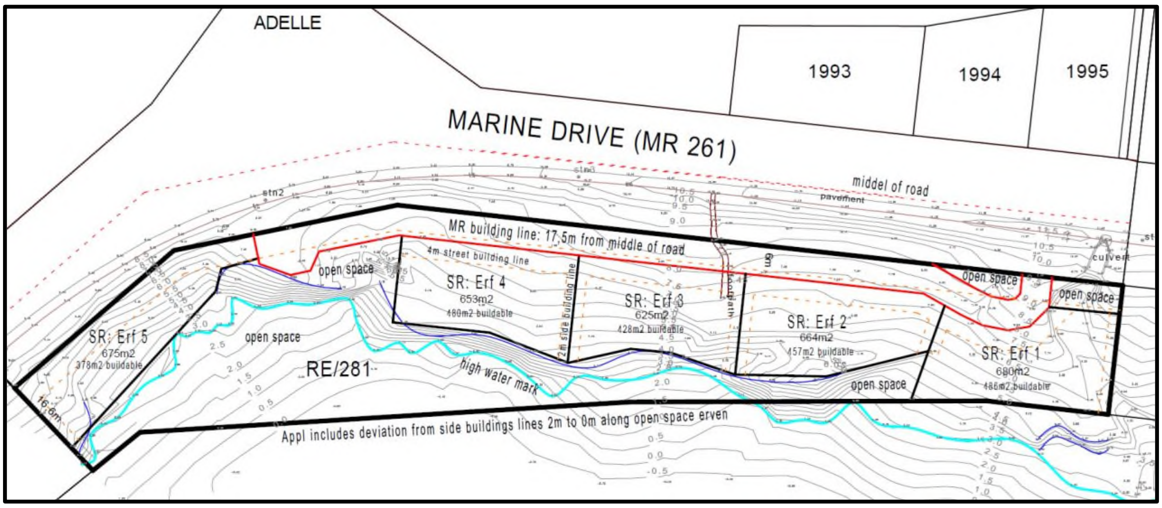


**Figure 4. Preliminary Site Development Plan.**

The proposed development entails 5 residential erven with a total area of 3277 m$^2$, situated on the slope above high water mark and below Marine Drive (Figure 4).

## 5 REGIONAL GEOLOGICAL SETTING

### 5.1 THE BEDROCK

The bedrock of Cape Agulhas area is the **Peninsula Formation** of the **Table Mountain Group** (TMG) which is exposed along the shoreline (Figure 5, Os). 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. This bedrock is not of palaeontological concern and is only mentioned for explanation of the geological map.

### 5.2 THE BREDASDORP GROUP

#### 5.2.1 Mio-Pliocene Marine Formations

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 continent.


**Figure 5. Surface geology of the Struisbaai area.**

### 5.2.2 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, such as around Bredasdorp.

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, with major erosion palaeosurfaces and calcrete pedocretes separating the subsidiary units of dune rock. Aeolianites correlated with the Wankoe Fm. are not mapped in the Cape Agulhas area where younger dune ridges migrated eastwards across the cape in the form of a large headland bypass dune system.

### 5.2.3 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 6), 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 6 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.

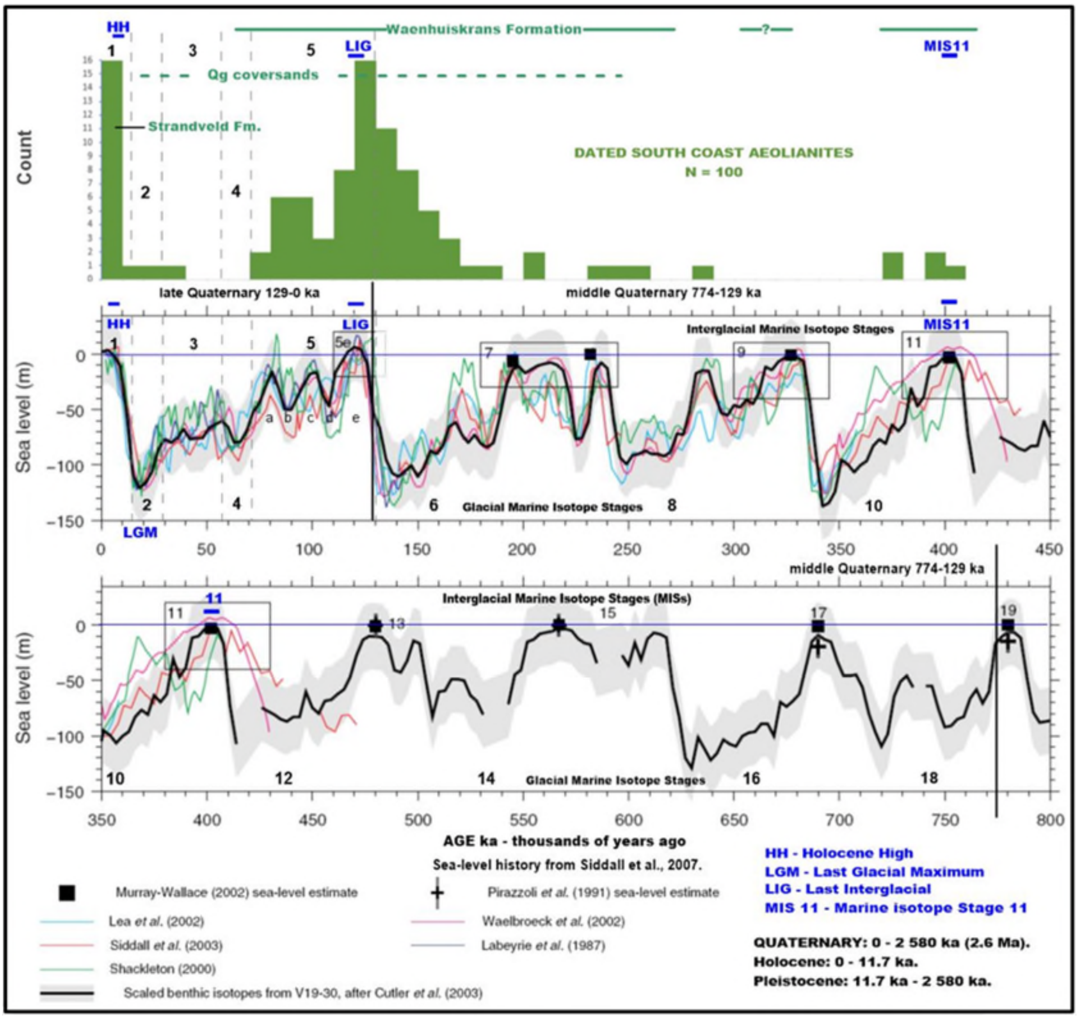


**Figure 6. Sea-level history for the last 800 ka with numbered Marine Isotope Stages showing the ages of the Klein Brak Formation raised beaches and OSL dates from South Coast aeolianites.**

The higher-lying, older raised beach occurs at 8-12 m asl. and relates to the **MIS 11 interglacial** high sea level that occurred around 400 ka (ka = thousand years ago). Most of the raised beach deposits that are exposed date to the **Last Interglacial** about 125 ka (Figure 6, LIG/MIS 5e) and are found up to ~8 m asl. due to storm deposition, but the mean sea level was about 5-6 m asl. The youngest raised beach is 2-3 m asl. and is known as the "**Holocene High**". It was deposited between 7-4 ka in as the coastline was slightly uplifted in response to the loading of the oceans with polar meltwaters. The high sea levels penetrated inland along valleys, expanding estuaries which today have their margins fringed by older estuarine deposits. These Quaternary-age raised beaches and estuarine deposits 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.

### 5.2.4 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 5) 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 (Figure 2) and internally the formation is comprised of “packages” of dune accumulation defined by separating reddish palaeosols and calcrete pedocretes.

The 100 *OSL dates/ages obtained from the Waenhuiskrans Fm. sands are shown in Figure 6 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 7. 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.**

* - see glossary.

The calcreted dune ridge near Soetendalsvlei is exposed in a road cutting on the R319, ~6 km north of Struisbaai, and shows the typical capping calcrete, softer underlying sands with root casts (rhizoliths) and aeolian dune bedding (Figure 7). The sands beneath the calcrete capping produced OSL dates of ~280 to ~210 ka (Bateman *et al*., 2004), indicating an older, mid-Quaternary age for the Waenhuiskrans Fm. at inland locations.

Closer to Cape Agulhas the aeolianite ridge west of the Project Area (Figure 5) dates to ~180-160 ka and it is expected that the aeolianite exposed in the Spookdraai road cutting is of similar age. These dates indicate that the headland bypass dunes continued to be active during the low sea levels of MIS 6 (Figure 6). Just south of the Project Area below Marine Drive is an exposure of a shelly beach deposit with boulders which underlies the Waenhuiskrans Fm. aeolianite (Malan & Viljoen, 1990) and presumably relates to the older, MIS11 high sea level.

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 (Figure 1, inset) 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 6).

Reworked and redistributed pale quartzitic coversands mantle much of the wider area (Figure 5, **Qg**), including covering much of the Waenhuiskrans Fm. and depicted as **Qg/Qw**. Near the coast the surficial coversands have been deposited subsequent to the LIG during the lower sea levels of the late Quaternary (Figure 6), 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 5, **Qsr**). These are loose, white, mainly non-vegetated dune sands blown from the beaches in the last several thousand years, during the Holocene (Figure 6), 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.

## 6 AFFECTED FORMATIONS

The wave-eroded bedrock quartzites of the **Peninsula Fm**. underlie the proposed development (Figure 5). The overlying deposits are not very thick and are expected to include raised beach deposits of the **Klein Brak Fm**. and windblown sands of the **Strandveld Fm**.

Accepting that the aeolianite exposed along the Spookdraai is of MIS 6 age (~180-160 ka) and post-dates the older MIS 11 high sea level (Figure 6), the LIG high sea level (5-6 m asl.) might have occupied the bedrock beneath the Project Area, with shoreline cliffs of aeolianite. However, it is also possible that the area remained covered by the Waenhuiskrans Fm. aeolianite during LIG times, with the cliffed shoreline situated to the seaward of the Project Area, as seen at other coastal localities where the LIG raised beach deposits are absent and pre-LIG aeolianites are cliffed along the modern shoreline.

The Holocene High (~3 m asl., about 7 ka) would have impinged on the Project Area strip which very likely was inundated during storm surges, with deposition of “stormbeach” deposits above the highwater mark. Reworked marine sands of the aeolian Strandveld Fm. occupy the surface.

## 7 ANTICIPATED IMPACT ON PALAEONTOLOGICAL RESOURCES

The palaeontological sensitivity of the Peninsula Fm. bedrock is rated HIGH (Figure 8), but the proposed small development is not expected to significantly impact the trace fossil content which might be preserved in the folded and deformed strata beneath the surficial sands. The Peninsula Fm. occurs extensively throughout the Cape Fold Belt.

The Klein Brak Fm. raised beach deposits typically consist of shelly sands and rounded gravels. In open-coast settings these Quaternary "raised beach" deposits include a fossil shell fauna which is mainly comprised of extant (living) species which are common today. In sheltered bay, estuarine and lagoonal settings, where warm-water conditions pertained locally, the deposits may also include a few tropical species of both West African and Indo-Pacific origin that no longer occur along the coast today, as well as a small number of extinct species. The shells present in the sheltered, warmer setting are known as the "Swartkops Fauna", from that estuary near Port Elizabeth. In addition to fossil shells, scattered fossil bones such as from whales, dolphins, seals and seabirds may occur in the deposits, but are generally very rare. These are not likely to be extinct species, but species beyond their modern-day ranges may occur.

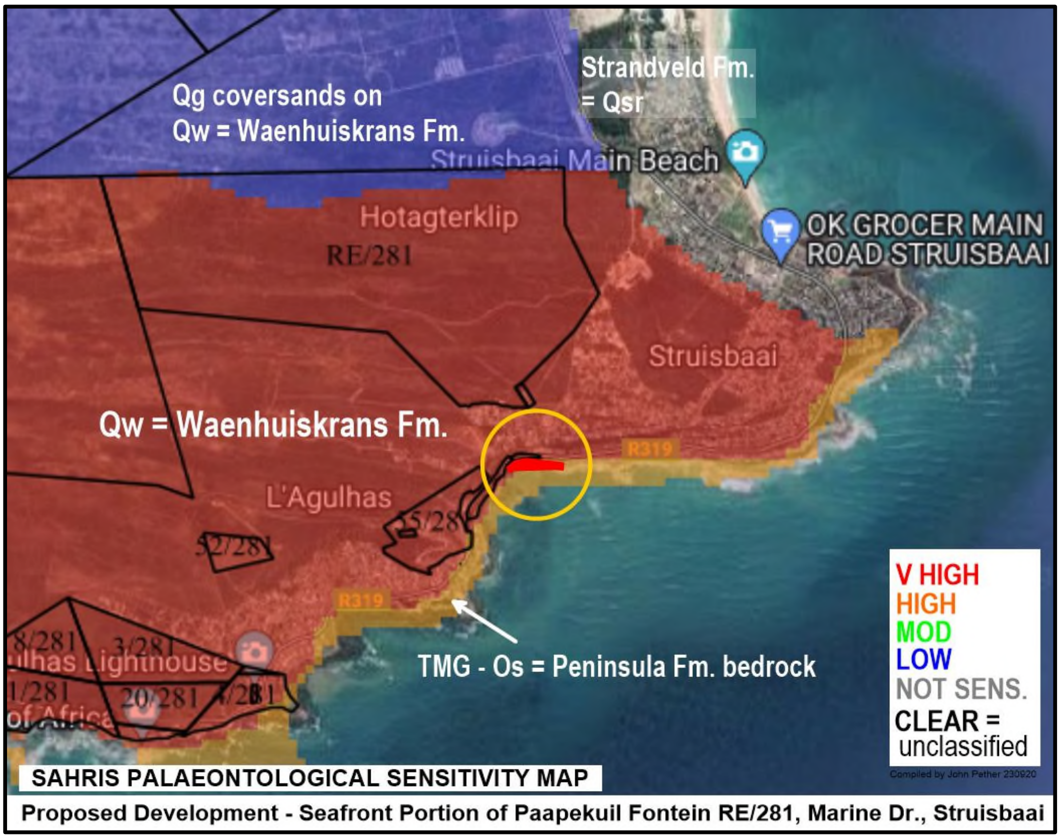


**Figure 8. Palaeontological sensitivities of formations in the Struisbaai area.**

The Klein Brak Fm. is not rated on the SAHRIS palaeontological sensitivity map, but is assigned CLEAR/Unclassified. It is suspected that beach deposits beneath the site are likely to be of Holocene age. Due to the open-coast setting of the Project Area a LOW sensitivity may be assigned to the raised beach deposits.

The marine sands have been eroded and wind-reworked to form a thin coversand equivalent to the Strandveld Fm. (also unclassified, Figure 8) Fossil material such as marine shells and bones in these sands are likely to be in an archaeological context. Any "subfossil" bones are expected to be of the extant fauna and a LOW sensitivity may be assigned to the aeolian coversands.

In summary, both the beach deposits and aeolian coversands of the Project Area are accorded LOW palaeontological sensitivity and in the impact assessment below are considered together. The intensity or magnitude of impact relates to the palaeontological sensitivities of the affected formations (Appendix 1) and the volume of disturbance by excavations. A typical conventional housing development entails trenches for foundations (~0.6 m depth) and services infrastructure (up to ~1.2 m depth) and will primarily affect the coversands and will probably intersect the beach deposits in places. In view of the vulnerability of the proposed seashore development to infrequent, but damaging storm surges it is possible that alternative structures may be built, such as plinth and girder construction which may involve less subsurface impact.

Note that the prime concern is for land and marine animal bones and archaeological material. The shell content in the Holocene raised beach deposits is not palaeontologically sensitive.

## 8 SUMMARY IMPACT TABLE

### 8.1 IMPACT ON THE STRANDVELD FM. COVERSANDS & KLEIN BRAK FM. RAISED BEACH DEPOSITS

| **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 coversands and beach deposits. | |
| | | |
| Extent and duration: | Study area and permanent. | Study area to regional and permanent. |
| Intensity/Sensitivity: | Low. | Low. |
| Consequence of impact or risk: | Loss of material palaeontological heritage. | Loss of material palaeontological heritage. |
| Probability of occurrence: | Possible. | Possible. |
| 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: | LOW NEGATIVE. | LOW TO MEDIUM POSITIVE. |
| | | |
| Degree to which the impact can be avoided: | Low. The locations of fossil bones in the deposits 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”.<br>• Cease construction on discovery of fossil bones and protect fossils from further damage.<br>• Contact appointed archaeologist/palaeontologist or HWC providing information and images.<br>• 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.<br>• Exposed fossiliferous sections in earthworks recorded and sampled by appointed specialist.<br>• Fossils and their contextual information must be deposited at a SAHRA/HWC-approved institution. | |

### 8.2 IMPACT RANKING

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

| | Extent | Duration | Intensity | Status | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Without mitigation** | Local 1 | Permanent 5 | Low 4 | Negative | Possible 2 | LOW 20 | M |
| **With mitigation** | Local 1 | Permanent 5 | Low 4 | Positive | Possible 2 | LOW 20 | M |

## 9 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.

Although the inspection of construction excavations may be specified in the Archaeological Impact Assessment, 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 fossil bones 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 2 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 building foundations, 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.

## 10 REFERENCES

Bateman, M.D., Holmes, P.J., Carr, A.S., Horton, B.P., Jaiswal, M.K. 2004. Aeolianite and barrier dune construction spanning the last two glacial-interglacial cycles from the southern Cape coast, South Africa Quaternary Science Reviews 23, 1681-1698.

Carr, A.S., Bateman, M.D., Roberts, D.L., Murray-Wallace, C.V., Jacobs, Z. & Holmes, P.J. 2010. The last interglacial sea-level high stand on the southern Cape coastline of South Africa. Quaternary Research 73: 351–363.

Malan, J.A. 1989. Lithostratigraphy of the Waenhuiskrans Formation (Bredasdorp Group). S. Afr. Committee for Stratigraphy, Lithostratigraphic Series No. 8, Geological Survey S. Africa.

Malan, J.A. & Viljoen, J.H. 1990. South Cape Excursion (PO3). Excursion guide for Geocongress '90. Geological Society of South Africa. 81 pp.

Roberts, D.L., Bateman, M.D., Murray-Wallace, C.V., Carr, A.S., Holmes, P.J. 2008. Last Interglacial fossil elephant trackways dated by OSL/AAR in coastal aeolianites, Still Bay, South Africa. Palaeogeog. Palaeoclim. Palaeoecol. **257**, 261–279.

Siddall, M., Chappell, J. & Potter, E.-K. 2007. Eustatic sea level during past interglacials. The Climate of Past Interglacials: Developments in Quaternary Science **7**: 75-92.

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## 1 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.*

## 2 APPENDIX 2. FOSSIL FINDS PROCEDURE

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

To this end, responsible persons must be designated. These may include:

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

### 2.2 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.

### 2.3 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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# 3 APPENDIX 3. 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 |

## 4 APPENDIX 4. DECLARATION OF INDEPENDENCE

**PALAEONTOLOGICAL IMPACT ASSESSMENT**

**PROPOSED SEAFRONT DEVELOPMENT ON A PORTION OF PAAPEKUIL FONTEIN RE/281**

**MARINE DRIVE, STRUISBAAI, CAPE AGULHAS MUNICIPALITY**

**BREDASDORP MAGISTERIAL DISTRICT, WESTERN CAPE**

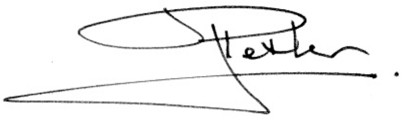
**Terms of Reference**

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: 27 September 2023

## 5 APPENDIX 5. CURRICULUM VITAE

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

Independent Consultant/Researcher recognized as an authority with 38 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) (~350 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 |

# 6 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 6).

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).

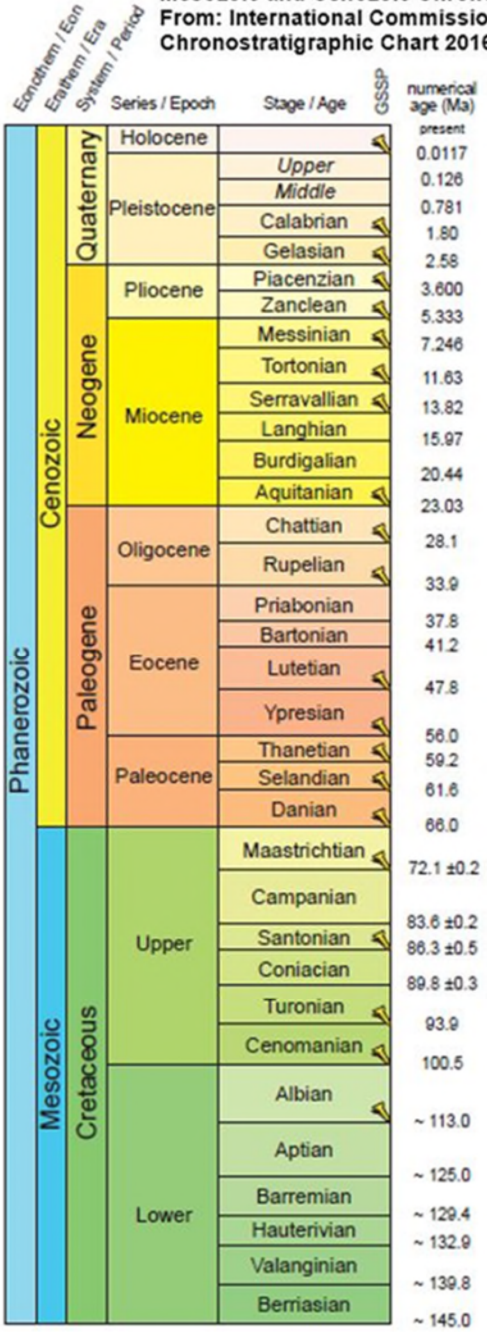
**GEOLOGICAL TIME SCALE TERMS**

For more detail see www.stratigraphy.org.

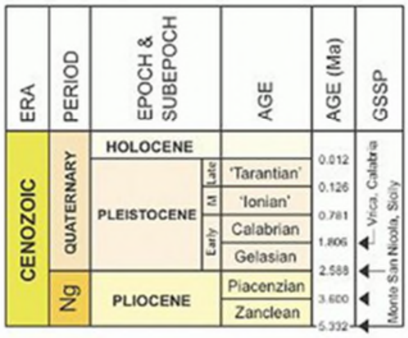
ka: Thousand years or kilo-annum ($10^3$ years). Implicitly means “ka ago” *i.e*. duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Not used for durations not extending from the Present. For a duration only “kyr” is used.

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 2016-12.pdf**




**ICS-approved 2009 Quaternary (SQS/INQUA) 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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