Palaeontological Assessment: Second Proposed Sand and Calcrete Mine DMR 10161MP, Farm Anyskop, Remainder Farm Langeberg 188, Vredenburg, Western Cape Province (1:50 000 3218 CA and CC Velddrif)

By
Graham Avery
(Sole Proprietor)

Archaeozoology, Stone Age Archaeology and Quaternary Palaeontology

Prepared for
Jayson Orton (ASHA Consulting (Pty) Ltd)

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Executive Summary

Graham Avery was commissioned by Jayson Orton (ASHA Consulting (Pty) Ltd) on behalf of their client to provide an assessment report on the palaeontological potential at a proposed sand and calcrete mine Pit#2 DMR 10161MP on Farm Langeberg 188, Vredenburg.

Proposed activity: Mining permit for sand and weathered calcrete.
Location: Anyskop Farm, Remainder farm Langeberg 188 Pit#2 DMR 10161MP, Vredenburg District (see Figures 1, 2).

The proposed sand and calcrete mine is located in a palaeontologically-sensitive region of potentially fossiliferous sediments underlain by bedrock of the Cape Granite Suite, which outcrops in the region but is not palaeontologically relevant in this instance. The proposed sand mine will focus on sediments from the Langebaan Formation of the Sandveld Group (see Table 1 for details) and will reach a depth of up to 3 m, which is above the water table.

Any very recent (not mineralized) bones on the surface are likely to result from Later Stone Age occurrences, recent natural deaths and agricultural activity and are unlikely to be palaeontological. The superficial cover sands are thin, have been affected by ploughing, and do not appear to have much palaeontological relevance at the site. It should be borne in mind, however, that Springfontyn Formation sediments at nearby West Coast Fossil Park (Langebaanweg) produced Pleistocene archaeological remains. Calcareous deposits of the Langebaan Formation, which outcrop extensively in the region and underlie the surface, sands do have palaeontological potential as indicated by the finding, during monitoring, of three stone artefacts on the cleared erosional surface of the calcrete and a number of Pleistocene mammal and tortoise bones from calcareous sediments on a spoil heap in Approved Pit #1 DMR 10122MP.

During mining, fossil finds may be encountered in the Langebaan Formation calcrete/calc-sands. Terrestrial molluscs (*Trigonephrus* sp.) are likely to occur sporadically throughout the area and are of relatively low significance. However, any fossils of other invertebrates or vertebrates from the Langebaan Formation would be significant, given the sparseness and patchiness of fossils in this formation, and would require careful recording and possible systematic excavation.

Middle Pleistocene stone artefacts may be encountered in Springfontyn Formation sediments at the erosional surface between the red-grey Springfontyn and the Langebaan Formation.

The excavations will not affect older/deeper formations that underlie the depth of the proposed mining in the Langebaan Formation.

Excavations into sediments not normally accessible to palaeontologists should be seen as providing opportunities to recover potentially important fossil material that would enable observations to be made about our past biodiversity and environments.

Palaeontological remains are rare, protected by the South African National Heritage Resources Act of 1999, and, if encountered, must be recorded by an appropriately-qualified person. A Workplan approval from Heritage Western Cape would be required to deal with any palaeontological occurrence. Protocols for managing palaeontological eventualities during the mining process should be in place before any excavation takes place. This would
include monitoring by the appointed specialist that must be initiated at the same time that mining begins. A training session for staff, including machine operators, prior to mining, is recommended.

Provided that the recommendations in this report are followed, there is no reason why establishment of the proposed sand and calcrete mine should not proceed.
Palaeontological Assessment: Proposed Establishment of a sand and calcrete mine, Farm Anyskop, Remainder Farm Langeberg 188 Pit#2 DMR 10161MP, Vredenburg, Western Cape Province (1:50000 3218 CA and CC Velddrif)

Introduction

Dr Graham Avery (Appendix 2: CV) was commissioned by Dr Jayson Orton (ASHA Consulting (Pty) Ltd) on behalf of his client Tip Trans Resources (Pty) Ltd to provide an assessment report on the palaeontological potential of the proposed establishment of a sand and calcrete mine (serving as a borrow pit for local road building) on the remainder of Farm Langeberg 188 proposed Pit#2 DMR 10161MP, Vredenburg (1:50 000 3218CA & CC Velddrif) (Figures 1, 2). See Figure 3 for indication of the current land surface.

Figure 1. Location (approx.) of the proposed sand mine (Pit #2 DMR 10161MP red star) on remainder Langeberg 188, 1:50 000 3218CA & CC Velddrif. Approved Pit #1 DMR 10122MP (blue star) is included for reference. The old borrow pits (gold star) are indicated.
Figure 2. Location of proposed sand mine Pit#2 DMR10161MP (red polygon) on remainder of Langeberg 188; Approved Pit#1 DMR 10122MP lies immediately to the south. The old borrow pits are arrowed.

Figure 3. View south across Pit#2 DMR10161MP with Approved Pit#1 DMR 10122MP visible in the background (Photo by J Orton).
Declaration

I have no financial or interest other than palaeontological or archaeological in the proposed development and will derive no benefits other than fair remuneration for consulting services provided.

Method

A background study of the proposed location was conducted by Dr G. Avery Archaeozoologist. The 1:125 Geological Series 3317B and 3318A and 1:250 00 Geological Series 3218 Clan William and other geological sources (Rogers 1980; Rogers 2006; Roberts and Brink 2002; Pether 2013c; Pether, Roberts, and Ward 2000; Almond 2012; Pether 2013b, 2013a, Avery 2016, Orton 2016) were consulted for background geological information. Since little is known about the sub-surface palaeontological potential of the specific locality, literature describing known palaeontological sites in the region was consulted. Observations from the Hydrological Report (GEOSS 2018) and the monitoring of Pit#1 DMR10122MP and two old borrow pits have been incorporated.

The specific site was not visited, since J. Orton, who conducted an archaeological survey of the surface area, is capable of recognizing, and would report on, any mineralized bone observed during his archaeological survey of the surface. He observed no mineralized bone on the surface and provided the site photograph (Figure 3) taken on 30 January 2018.

Results of the Study

Geology and lithology

The Cenozoic sediments of the region are in the Sandveld Group (Roberts et al. 2006; Pether 2013b; Pether, Roberts, and Ward 2000; Pether 2013c), (Figure 4, Table 1), which include shallow marine, back barrier, estuarine, fluvial and aeolian contexts (Rogers 1980, 1982, 1983; Rogers 2006; Hendey 1981; Roberts and Brink 2002; Almond 2012; Pether 2013b, 2013c; Roberts et al. 2011; Hendey 1982) dating from the Miocene, through the Pliocene, Pleistocene and Holocene. Palaeozoic Cape Granite Suite bedrock outcrops in places (1: 125 000 Geological Series 3317B and 3318A; 1:250 00 Geological Series 3218 Clan William).

General surface geology is shown in Figure 4 and a summary of the regional stratigraphy and lithology of the Sandveld Group is shown in Table 1. A composite for the Sandveld Group at the nearby Langebaanweg site (West Coast Fossil Park) is illustrated by Figure 5. It should be noted that some published terminology has been updated, The Bredasdorp Formation, now named The Sandveld Group, being an example.

The Langebaan Formation into which the proposed calcareous sand mine will be dug is a complex series of dune build up over considerable time (Table 1), through the late Pliocene, Pleistocene and the Holocene (Roberts et al. 2009). The Formation extends >20 m deep at Langebaanweg (West Coast Fossil Park) (Figure 5) and is some 15 m in depth at the Saldanha Steel site (Roberts 1997b) and a borehole between them on Langeberg 188. Should remnants of the Springfontyn Formation, which occurs unconformably on the Langebaan Formation erosion surface, be preserved fossiliferous sediments, including Pleistocene stone artefacts may occur within the projected depth of the mine;
Figure 4. Surface geology in the region (from 1:125 000 Geological series 3317B and 3318A Saldanhabaai). Springfontyn Formation (Q1, Q2 = Middle Pleistocene – light-grey to pale-red sandy soil); and Langebaan Formation (QC = Quaternary Langebaan Formation – limestone and calcrete, partially cross-bedded, calcified parabolic dune sand (and see Table 1)) are being relevant to this mining application. G3 = Cape Granite Suite coarse granite) (see Table 1). The proposed Pit#2 DMR10161 MP area is starred; two Langebaan Formation fossil localities, Yzervarkensrug and Langebaanweg (WCFP), are framed in Blue.
Table 1. Summary of the Sandveld Group. (Pether, Roberts, and Ward 2000; Pether 2013b, 2014; Roberts et al. 2006) and G Avery (pers. observation). Ma = Million years ago; ka = Thousand years ago. Formations relevant to Pit#2 DMR10161MP are arrowed.

Note: chronology for the base of the Lower Pleistocene Boundary has been formally re-defined to an earlier date of 2.58 Ma; the base of the Holocene has also been formalized at 11.8 ka (Gibbard et al. 2010).

<table>
<thead>
<tr>
<th>Formation</th>
<th>Age and Lithologies</th>
<th>Fossil Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witzand</td>
<td>Holocene and recently active calcareous dune fields and oordons (&lt;12 ka)</td>
<td>Rare sub-fossils of importance for historical fauna distribution. Mainly Later Stone Age archaeological sites.</td>
</tr>
<tr>
<td>Springfontyn</td>
<td>Pleistocene to Recent (Holocene) quartzose sand dunes, silts and peats (&lt;2 Ma)</td>
<td>Mineralized bones generally sparse, but can be prolific in some areas, e.g. Elandsfontein and part of Baard’s Quarry. High significance</td>
</tr>
<tr>
<td>Langebaan</td>
<td>Late Quaternary aeolianites &lt;3 Ma</td>
<td>Mineralized bones moderately common. Local to high significance. Extends under sea. Local to high significance</td>
</tr>
<tr>
<td>Veldrif</td>
<td>Quaternary raised beaches and estuarine deposits &lt;1.2 Ma. Sea levels below ~15 m a.s.l.</td>
<td>Marine molluscs common and rare bones at or near the coast. High significance</td>
</tr>
</tbody>
</table>

Marine erosion surfaces below ~15 m a.s.l.

- Of indet. sands

Langebaan | Late Pliocene to mid-Quaternary aeolianites. <3 Ma | Molluscs and sparse (can be patchy concentrations, e.g. Langebaanweg, bones of terrestrial and marine forms. Extends under sea. Local to high significance |

Uyekraal -- Previously subsumed in the upper Varswater Fm | Mid-Pliocene marine deposits ~3 Ma. Sea-level max. ~35 m a.s.l | Shell fossils common, local significance. Fossil bones very sparse, high significance |

Marine erosion surface to ~35 m a.s.l.

- Of indet. sands

Langebaan | Earlier Pliocene aeolianites <3 Ma. | Fossil bones moderately common, local to high significance |

Varswater – upper | Later early Pliocene regressive deposits of wider area. 5-4 Ma. Sea-level max. ~50-60 m a.s.l. | Fossil bone rare, high significance. Poorly known, fossil shells of high significance |

Varswater – lower | Early Pliocene transgressive marine deposits in embayments (upper KGM?, LC3M and MPFM members | Fossil bone common locally, high significance. Shells very sparse, high significance |

Marine erosion surface to ~60 m a.s.l.

- Very old indet. sands

Prospect Hill | Miocene aeolianite 12 to 9 Ma | Fossils very sparse – high significance |

Saldanha | Miocene marine deposits (predicted presence). 17-14 Ma. Sea-level max. ~90 m a.s.l. May include the lower KGM? | Very few fossils recovered, high significance if found. |

Marine erosion surface to ~100 m a.s.l.

- Plant microfossils – high significance

Langenenheid Clayey Sand -- Previously a member of the Lower Varswater Fm | Miocene early-transgression estuarine deposits (prev. LC3M Member in lower Varswater Fm.). 18-17 Ma. | Plant microfossils – high significance |

Elandsfontyn | Miocene fluvial coarse, angular sands, muds and carbonaceous sediments. ~15 Ma to ~12 Ma | Microfossils, including pollen, and macro remains of plants, high significance |
Figure 5. Composite summary of the lithostratigraphy of the Sandveld Group and fossil-bearing formations at Langebaanweg (West Coast Fossil Park), which represent a large part of the Saldanha region (Roberts et al. 2011). Note that fossils occur in the upper and lower parts of the Langebaan Formation; and Early Stone Age artefacts and fossil bone may occur in the overlying Springfontyn Formation (see Anyskop and Elandsfontein in Table 2).

Known Sites in the Region

Bones, recorded on the surface are likely to be of Holocene age or very recent and related to agricultural practices; they are not mineralized and of no relevance to this study unless associated with archaeological remains.
A fossil record for the proposed Pit#2 DMR10161MP calcareous sand mine locality does not currently exist. Nevertheless, sufficient information is available to make at least general comments on what may be encountered in the Langebaan Formation (Figure 6a,b, Table 2).

While it should be appreciated that, although there are exceptions such as the brown hyaena den accumulations at Besaansklip (Brink 2005), Sea Harvest (Grine and Klein 1993; Volman 1978) and recently discovered new occurrences (GMC) at Saldanha Bay Harbour (G Avery pers. obs.) and Hoedjiespunt (Berger and Parkington 1995; Stynder 1997; Will et al. 2013) in which large numbers of vertebrate bones, including extinct species, are preserved, palaeontological and archaeological remains are more likely to be sporadically and/or sparsely distributed in patches or as isolated items. Palaeontological remains are widely distributed through the Langebaan Formation (Pether 2010, 2009). Examples are at SALKOR (Pether 2013c), Langebaanweg (WCFP) (Hendey 1981, 1982) and Namaqua Sands (Pether 2006); a borrow pit on Namaqua Sands yielded marine vertebrate teeth and molluscs (Pether 2006). In the West Coast Fossil Park precinct on Anyskop (and Table 2), fossil gastropods, mammals, tortoises and birds occur in the Langebaan Formation. Anyskop, an Early, Middle and Later Stone Age occurrence with fragmentary bone in Springfontyn Formation sediments, is also indicative of potential, should such sediments be preserved over the Langebaan Formation (Dietl, Kandel, and Conard 2005; Conard 2001b, 2002).

![Figure 6a. Location of known palaeontological sites and existing sand and calccrete mine (CMine) in the Langebaan Formation near the proposed mine location which is starred (details in Table 2).](image-url)
Current monitoring of Pit#1 DMR10122MP has revealed one small pocket of bones, including *Mystromys albicaudatus* white-tailed rat, *Bathyergus suillus* Cape dune mole-rat, *Chersine angulata* angulate tortoise and snake in Langebaan Formation sandy calcrite found by J Orton (Orton 2018, Figure 7) and three stone artefacts (Figure 8), probably of the Middle Pleistocene Early Stone Age, were exposed on the Springfontyn/Langebaan Formation erosional surface (Avery 2018 in prep.).

Sparse stone artefacts of probable Early Stone Age were encountered in Approved Pit#1 DMR 10122MP at the Springfontyn/Langebaan Formation erosion surface (Avery 2018 in prep.).

Table 2. Names and summary details of palaeontological and Pleistocene archaeological sites from the region. See Table 1 for lithological and chronological details regarding the formations within which fossils and/or stone artefacts occur.

<table>
<thead>
<tr>
<th>Site</th>
<th>Formation</th>
<th>Selected References</th>
<th>Type of Occurrence</th>
<th>Acronym</th>
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</thead>
<tbody>
<tr>
<td>Besaansklip – hyaena</td>
<td>Langebaan</td>
<td>(Brink 2005); National Museum, Bloemfontein</td>
<td>Palaeontology. Significant brown hyena den accumulation in crevices in Langebaan Formation.</td>
<td>Bklip</td>
</tr>
<tr>
<td>Donkergat – Military area</td>
<td>Langebaan (upper)</td>
<td>G Avery pers. observation</td>
<td>Palaeontology. Sparse bones of small terrestrial vertebrate (<em>Bathyergus suillus</em>) and terrestrial gastropod <em>Trigonephrus globulus</em> in aeolianite exposure.</td>
<td>Dgat</td>
</tr>
</tbody>
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Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed P#2 DMR 10161MP
<table>
<thead>
<tr>
<th>Site</th>
<th>Formation</th>
<th>Selected References</th>
<th>Type of Occurrence</th>
<th>Acronym</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eensaamheid – Wind Farm proposal</td>
<td>Springfontyn; Langebaan; Varswater</td>
<td>(Avery and Avery 2009)</td>
<td>Palaeontology. Langebaan Formation included fossil gastropod Trigonephorus globulus. Potential, given depth of proposed foundations reportedly to &gt;60 m.</td>
<td>Ens</td>
</tr>
<tr>
<td>Elandsfontein – “Main” Site</td>
<td>Springfontyn; Langebaan; Varswater; Elandsfontyn</td>
<td>(Archer 2010; Avery 1988, 2016 In Prep; Braun, Levin, Roberts, et al. 2013; Braun, Levin, Stynder, et al. 2013; Inskeep and Hendey 1966; Klein et al. 2007; Klein 1978; Klein and Cruz-Uribe 1991; Luft, Lee-Thorp, and Avery 2000; Roberts and Braun 2014; Smith and Stynder 2015; Stynder 2009; Singer and Wymer 1986; Rogers 1980; Drennan 1953, 1954; Klein 2009; Volman 1984; Goodwin 1953); Iziko South African Museum Cenozoic Collections, UCT</td>
<td>Palaeontological and Pleistocene Archaeological. Provincial Heritage Site. Well-preserved fossils and artefacts exposed in extensive dune slacks by wind erosion. Diverse terrestrial vertebrate taxa, plants (pollens); Early Stone Age (ESA) – Late Acheulean. in probable association with fossils in the Cutting 10 excavation. Rare Middle Stone Age (MSA) – Still Bay artefacts. Early Homo sapiens (Homo heidelbergensis) cranial remains contemporary with ESA. Hyaena accumulations (including ‘Bone Circle’ (EFTB), contiguous with general surface.</td>
<td>EFT Main</td>
</tr>
<tr>
<td>Elandsfontein – Wes</td>
<td>Springfontyn; Langebaan erosion surface</td>
<td>(Mabbutt 1956; Singer and Wymer 1968; Roberts and Braun 2014; Plasket 2013; Avery 2016 In Prep; Goodwin 1953; Halkett and Webley 2015)</td>
<td>Palaeontology and Pleistocene Archaeology. Sparsely scattered mineralized bones, rare stone artefacts, exposed in blow outs and by excavations for mine infrastructure.</td>
<td>EFTW</td>
</tr>
<tr>
<td>Hoedjiespunt – Middle Stone Age DAMA site</td>
<td>Langebaan</td>
<td>(Woodborne 2000; Kyriacou et al. 2015; Stynder et al. 2001; Stynder 1997; Will et al. 2013); Iziko South African Museum Cenozoic Collections, UCT</td>
<td>Middle Stone Age artefacts associated with shell midden, which includes terrestrial and marine vertebrate taxa.</td>
<td>HDP1</td>
</tr>
<tr>
<td>Kraalbaai – trackway</td>
<td>Upper Langebaan (Kraalbaai Member)</td>
<td>(Roberts and Berger 1997; Roberts and Brink 2002)</td>
<td>Trackway of modern human Homo sapiens footprints; spoor of probable hyaena. Exposed between fractured cross-beded structures of aeolianite. Rare vertebrate bones.</td>
<td>LLtrack</td>
</tr>
<tr>
<td>Site</td>
<td>Formation</td>
<td>Selected References</td>
<td>Type of Occurrence</td>
<td>Acronym</td>
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<tr>
<td>Langeberg 188 Pit#1 DMR 10122MP – fauna</td>
<td>Langebaan</td>
<td>(Avery 2016, Orton2018, Avery 2018 in prep.)</td>
<td>Palaeontological. Sparse mammal and reptile bones, including Mystromys albicaudatus, Bothryergus suillus, Chersine angulata and snake with calcareous encrustations, probably from erosional interface between Springfontyn and Langebaan Formations.</td>
<td>L188</td>
</tr>
<tr>
<td>Langeberg 188 Pit#1 DMR 10122MP – Human</td>
<td>Springfontyn</td>
<td>(Avery 2016, Avery 2018 in prep.</td>
<td>Archaeological. Three Early Stone Age stone artefacts, at erosional interface between Springfontyn and Langebaan Formations.</td>
<td>L188</td>
</tr>
<tr>
<td>Langebaanweg – E Quarry Lfm</td>
<td>Elandsfontyn</td>
<td>(Coetzee 1978a, 1978b); Iziko South African Museum Cenozoic Collections</td>
<td>Macro and micro plant remains, underlying Varswater Formation, encountered during boring for water.</td>
<td>LBW</td>
</tr>
<tr>
<td>Langebaanweg – Anyskop Springfontyn</td>
<td></td>
<td>(Dietl, Kandel, and Conard 2005; Conard 2001a; Conard 2002); Iziko South African Museum Cenozoic Collections</td>
<td>Palaeontological and Archaeological. Middle and Late Pleistocene archaeological. Early Stone Age (ESA) artefacts – Late Acheulean – and Middle Stone Age – Howiesons Poort.</td>
<td>Akop</td>
</tr>
<tr>
<td>Saldanha Steel</td>
<td>Langebaan; Varswater</td>
<td>(Pether 1995; Roberts 1997a; Avery and Klein 2011; Avery 1994); Iziko South African Museum Cenozoic Collections</td>
<td>Palaeontological. Sub-surface, reached during deep excavation for foundations. Some terrestrial Trigonemphuris globulus in Langebaan Fm. In the Varswater Fm. mostly marine molluscs with sparse marine vertebrate species, some extinct. Recorded presence of “crocodile” is incorrect – teeth are of fish.</td>
<td>SS</td>
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<tr>
<td>Site</td>
<td>Formation</td>
<td>Selected References</td>
<td>Type of Occurrence</td>
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<tr>
<td>Saldanha Yacht Club – Barn Owl</td>
<td>Langebaan</td>
<td>(Manthi 2002)</td>
<td>Palaeontological. Barn Owl roost with micromammal taxa.</td>
<td>YC</td>
</tr>
<tr>
<td>Saldanha Harbour GMC1 – hyaena</td>
<td>Langebaan</td>
<td>Avery pers. observ.</td>
<td>Palaeontological. Significant brown hyaena den with terrestrial and marine taxa and modern <em>Homo sapiens</em> remains. In crevices eroded into the Langebaan Formation. Rhizoliths (root castes) and <em>Trigonephurus globulus</em> in aeolianites.</td>
<td>GMC1</td>
</tr>
<tr>
<td>Saldanha Harbour GMC3&amp;4 – hyaena</td>
<td>Langebaan</td>
<td>Avery pers. observ.</td>
<td>Palaeontological. Significant brown hyaena den with terrestrial and marine taxa and modern <em>Homo sapiens</em> remains. In crevices eroded into the Langebaan Formation. Rhizoliths (root castes) and <em>Trigonephurus globulus</em> in aeolianites.</td>
<td>GMC 3&amp;4</td>
</tr>
<tr>
<td>Saldanha Harbour Sea Harvest – hyaena</td>
<td>Langebaan</td>
<td>(Grine and Klein 1993; Butzer 2004; Klein 1983); Iziko South African Museum Cenozoic Collections</td>
<td>Palaeontological. Significant brown hyaena den with terrestrial and marine taxa and modern <em>Homo sapiens</em> remains. In crevices eroded into the Langebaan Formation. Rhizoliths (root castes) and <em>Trigonephurus globulus</em> in aeolianites.</td>
<td>SH</td>
</tr>
<tr>
<td>Saldanha Harbour Sea Harvest – Middle Stone Age</td>
<td>Langebaan</td>
<td>(Grine and Klein 1993; Volman 1978; Butzer 2004); Iziko South African Museum Cenozoic Collections</td>
<td>Archaeological. Middle Stone Age shell midden contiguous with adjacent hyaena dens. In eroded Langebaan Formation crevice/overhang.</td>
<td>SH</td>
</tr>
<tr>
<td>SALKOR</td>
<td>Langebaan</td>
<td>(Pether 2013c)</td>
<td>Palaeontological. Isolated bovid mandibular fragment.</td>
<td>SAL</td>
</tr>
<tr>
<td>Skurwerug</td>
<td>Langebaan</td>
<td>(Hendey and Cooke 1985; Tankard 1976; Rogers 1982); Iziko South African Museum Cenozoic Collections</td>
<td>Palaeontological. Excavations for crude oil storage encountered a small patch of important Plio-Pleistocene terrestrial fossils, including an extinct pig.</td>
<td>Srug</td>
</tr>
<tr>
<td>Spreeuwalle</td>
<td>Langebaan</td>
<td>(Flemming 1977; Avery et al. In Prep; Avery and Klein 2009); Iziko South African Museum Cenozoic Collections</td>
<td>Palaeontological and Pleistocene archaeological. Diverse Late Pleistocene terrestrial taxa; aquatic and terrestrial molluscs. Date on overlying calcrite duricrust of 59 ka (W. Sharp, pers. comm.). Now intertidal – formed during period of lower sea level.</td>
<td>SPW</td>
</tr>
<tr>
<td>Swartrie</td>
<td>Langebaan</td>
<td>G Avery pers. observation</td>
<td>Palaeontological. Intertidal. Patch of sparse vertebrate bones in eroding intertidal platform.</td>
<td>Sriet</td>
</tr>
</tbody>
</table>
Further south at Ysterfontein a rock shelter in the Langebaan Formation calcrite has a deep sequence of Middle Stone Age shell middens and, in an adjacent overhang, a hyaena den accumulation (Avery et al. 2008; Halkett et al. 2003; Klein et al. 2004). Two other hyaena den occurrences at Ysterfontein have yielded diverse mammalian, bird and reptile taxa (RG Klein in prep.).

Further inland, sparse mineralized bones and Early Stone Age artefacts lie in Springfontyn sediments and on the erosion surface of the Springfontyn/Langebaan Formations on Elandsfontein 349 and Elandsfontein Wes and surrounds (Figure 6a, b) (Singer and Wymer 1968; Braun, Levin, Stynder, et al. 2013; Roberts and Braun 2014; Plasket 2013; Orton 2007; Avery 2015; Avery 2016 in prep.).

**Palaeontological Potential**

“The main bulk of aeolianites is not very fossiliferous, but fossil bones from the Langebaan Formation have been a prime source of information on past (different) Quaternary faunas and archaeology. Most of the finds are expected to be sporadic occurrences of local significance, but significant bone concentrations occur in certain contexts. Depending on the nature of the discovery, the significance may escalate to high (international interest), such as finds of unexpected or new species or hominid finds” (Pether 2013c).

The proposed site Pit#2 DMR 10161 MP is close to and lithologically essentially similar to Approved Pit #1 DMR 10122MP (Avery 2016); the palaeontological potential of each is almost certainly similar, if not identical.

At the same time, it is noted that excavation at Approved Pit#1 DMR 10122MP was initiated before the palaeontological specialist was notified. This may well have resulted in the loss of palaeontological material as evidenced by the lucky find, on a spoil heap during monitoring, of fossil mammal bones, including the jaw of a white-tailed rat *Mystromys albicaudatus* (Figure 7, Orton 2018), with calcareous encrustations of the Langebaan Formation; in addition, three stone artefacts (Figure 8, Avery 2018 in prep.) were observed on the cleared surface of the Langebaan Formation. It is, therefore, emphasized that the appointed monitor should be notified of the date excavation is to start and monitoring is initiated at the same time.

<table>
<thead>
<tr>
<th>Site</th>
<th>Formation</th>
<th>Selected References</th>
<th>Type of Occurrence</th>
<th>Acronym</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vredenburg Urban – hy</td>
<td>Springfontyn or Langebaan</td>
<td>P. Haarhof, pers. comm., G Avery, pers. observation</td>
<td>Palaeontological. Small pocket of bones against granite outcrop. Probably collected by hyaena.</td>
<td>VU</td>
</tr>
</tbody>
</table>

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed P#2 DMR 10161MP
Figure 7. Mandible of *Mystromys albicaudatus* (scale in cm) recovered by J Orton in the mined area of Approved Pit #1 DMR 10122MP (Orton 2018). Note the calcareous encrustation indicating its origin in the calcareous Langebaan Formation being mined (Photo by J Orton).

Figure 8. Three stone artefacts from the Springfontyn/Langebaan Formation erosional surface exposed for mining (30 cm ruler as scale). It is not clear whether they were *in situ* or whether the calcrete adhesions reflect secondary cementation.

The superficial sands over the proposed sand mine area have previously been ploughed, seem relatively thin and are unlikely to have palaeontological potential, unless a feature like a crevice with bone infill is encountered, or palaeontological and/or Pleistocene archaeological remains exist on the erosion surface or within the Langebaan Formation.

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed P#2 DMR 10161MP
Previous calcarious sand borrow pits excavated by the land owner were also investigated (during monitoring of Approved Pit#1 DMR 10122MP). In these, Light red/grey sediments of the Springfontyn Formation that overlie the erosional surface of the calcarious Langebaan Formation deposits west of Pit#2 are not as deep (e.g. Figure 9) (range from zero to 2 m) as those found in the Geotech investigation for Pit#2 (GEOSS 2018) suggesting some similarity with Pit#1 and variation in the Langebaan Formation surface topography; no palaeontological or archaeological material was observed in the old exposed sections.

With respect to Pit#2 DMR 10161MP, the greater depth of Springfontyn Formation sand reported from a test hole (GEOSS 2018) may increase the potential for encountering preserved Middle Pleistocene stone artefacts and/or fossil bones, particularly if the surface of the Langebaan Formation there was less affected by erosion.

Figure 9. Relatively shallow light red/grey Springfontyn Formation sediments (~0.5 m) overlying the calcarious Langebaan Formation in an old calcrete borrow pit.

The sub-surface palaeontological potential can, however, only be assessed once digging is initiated; but it is entirely possible (Table 2; Appendix 1: Figures 10 to 19) and Orton (2018) and Avery (2018) that excavations into sediments not normally accessible to palaeontologists, particularly in the Langebaan Formation, may encounter sporadic palaeontological and Pleistocene archaeological remains as has been the case in Approved Pit #1 DMR 10122MP. Rather than treating this as a negative, appropriate management may provide opportunities to recover important fossil material that enable observations, otherwise impossible, to be made on palaeo-biodiversity, extinct species and Pleistocene archaeology.

Current knowledge is adequate, given the wide distribution of known localities, including Pit#1 DMR 10122 MP, to make predictions. It is not possible to exclude the possibility that sporadically- and/or sparsely-distributed sub-surface fossils and/or stone artefacts will be encountered during the sand mining, particularly in the Springfontyn and Langebaan Formation sand sediment and calcarious deposits. Small pockets of bone can occur, for instance, where bone accumulators like hyaenas, Jackals or porcupines used natural holes/burrows or those dug by aardvarks; older and younger sediments, too, may contain ancient wetland deposits and/or more recent sub-fossils.
Palaeontology Resources: Summary of impact assessment.

| Potential impacts on palaeontological and Pleistocene archaeological resources |
|---------------------------------|-----------------|
| Nature of impact:              | Negative and direct |
| Extent of impact:              | Site specific to region |
| Consequences of impact:        | Medium |
| Duration of impact:            | Permanent |
| Probability of occurrence:     | Definite |
| Confidence:                    | Sure |
| Degree to which the impact can be reversed: | Irreversible |
| Degree to which the impact may cause irreplaceable loss of resources: | Irreplaceable |
| Significance rating of impact prior to mitigation | Medium to high |
| Significance rating of impact after mitigation | Low |

**Conclusion**

- Excavations into sediments not normally accessible to palaeontologists should be seen to provide opportunities to recover potentially-important fossil material that enables observations to be made, about geology and past sea levels, climates, environments and biodiversity, that would otherwise be impossible.

- Palaeontological remains in the Langebaan Formation are sporadically and/or sparsely distributed and rare but, if encountered, are important and must be recorded by an appropriately-qualified person. While the mining operation may not encounter palaeontological remains, the richness, amongst others, of the globally important Langebaanweg (West Coast Fossil Park) fossil landscape, along with Elandsfontein, Besaansklip, Sea Harvest, Hoedjiespunt and the Swartklip hyaena accumulation (Klein 1975) and their important contributions to knowledge should not be lost sight of.

- While no significant fossil evidence is available for Langeberg 188 proposed Pit#2 DMR 10161MP, it is evident from Approved Pit #1 DMR 10122MP and regional observations, that this does not mean that potential is lacking in the Langebaan Formation here and elsewhere.

- Mining should be monitored by a palaeontologist or archaeologist with appropriate palaeontological knowledge. This should start at the same time as mining and the subsequent frequency of this is to be worked out a priori with the contractor to minimize time spent on site.

- A training session to familiarize contractor’s staff, including machine operators, has proved important at other sites in the Saldanha region and has led to more efficient recovery of scientifically important material with minimal or no delays; given the scale of
mining a temporary shift of the operation a few metres until a find is assessed and removed should not be a problem.

- Given the known palaeontological potential of the region, mitigationary action, beyond simple recording and recovery during monitoring, including the possibility of systematic excavations, while unlikely, may be necessary.

- Provided that the recommendations in this report are followed, current information indicates that the proposed sand mine will not impact significantly on palaeontological remains; if fossils are encountered, a management plan will be in place.

**Provided that the recommendations below are adhered to the proposed Sand mine can be allowed to proceed from the palaeontological perspective.**

**Recommendations**

1. Protocols for dealing with palaeontological monitoring, recovery of sub-surface palaeontological/archaeological material and possible further mitigation must be included in the Environmental Management Plan (EMP).

2. Any material recovered will be lodged in the Quaternary and/or Pre-Colonial Archaeology collections of Iziko South African Museum.

3. Funds must be available *a priori* to cover costs of fieldwork and one date should the need arise.

**Palaeontological Points for EMP**

- Pether (2006, 2011) and (Avery 2016) provide useful guidelines for the formulation of palaeontological protocols.

- Mining will provide an opportunity to assess the sub-surface palaeontological and archaeological potential and geology of the site.

- All fossils are protected by law. Should anything of a palaeontological or archaeological nature be encountered on site by the Contractor (or any other party), e.g. bones, artefacts or wetland deposits, work is to be stopped in that area immediately, and the OM / Principal Agent notified. Failure to do so will result in a penalty and this must be carefully explained to workers during the Environmental Education Programme undertaken by the OM.

  The author of this report can assist with training in the value and basic recognition of palaeontological material from the sediments to be mined.

- In the event of palaeontological material being encountered, the OM will demarcate the area and notify the appointed specialist (palaeontologist/ archaeologist with appropriate experience) who will view the material and ascertain whether further study of the area is required.

- Should the specialist confirm a genuine fossil or sub-fossil and recommend further study of the area, work in the applicable area is to cease until further notice while arrangements are put in place. The appointed palaeontologist/ archaeologist will report finds to Heritage Western Cape (HWC).
The removal of discovered palaeontological or archaeological remains, by a contracted specialist shall be at the expense of Tip Trans Logistix (Pty) Ltd.

Heritage Permits Required

- The primary heritage legislation that needs to be considered is The National Heritage Resources Act 25 of 1999, amendments and regulations (www.sahra.org.za). All heritage material, including human burials, is included.
- Clearance in terms of the National Heritage Resources Act of 1999 will be required before the development can proceed.
- A Workplan approval for the disturbance and removal of palaeontological material will be required from Heritage Western Cape; potential delays could be minimized by the appointed specialist obtaining such approval before mining is initiated.

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Dr Graham Avery MRSSAf
20 February 2018

Curator in Natural History Collections Department (retired)
Archaeozoologist
Honorary Research Associate: Iziko Museums, Natural History Collections Department
Honorary Research Associate: University of Cape Town, Archaeology Department

25 SanBernardo
18 De Lorentz Street
Gardens 8001

gavery@iziko.org.za; drgavery97@gmail.com

Personal Tax Reference No: 0092024033
G Avery
Standard Bank
Acct: 070002061
Appendix 1

Images illustrating examples of some significant Palaeontological and Pleistocene Archaeological occurrences associated with Springfontyn and Langebaan Formation sediments

Figure 10. The Besaansklip locality with brown hyaena den accumulation within cavities in older Langebaan Formation calcrete (photo by JS Brink).

Figure 11. Besaansklip brown hyaena Den. A group of fossil bones in a cavity in older Langebaan Formation calcrete (photo by JS Brink).
Figure 12. Besaansklip excavation showing cavities in older calcrete after removal of bones (photo by JS Brink).

Figure 13. Langebaan Formation at Sea Harvest showing the kind of overhang/crevice (arrowed) in which brown hyaenas accumulated bones (photo by G Avery).
Figure 14. Spreeuwalle (Figure 6) section exposed by a storm. Fossils occur in humified wetland vegetation deposits overlain by a duricrust dated to ~59 ka (modified from photo by P Haarhoff).

Figure 15. Humified lens at Spreeuwalle with fossil jaw of extinct Cape zebra and teeth of an eland sandwiched between concentrations of tiny aquatic molluscs (photo by G Avery).
Figure 16. *Trigonephrus globulus* shells in Langebaan Formation surface calcrete erosion surface on Eenzaamheid (photo by G Avery).

Figure 17. Cross-bedded dune laminations of Langebaan Formation aeolianites at Kraalbaai in which human footprints were preserved (photo by G Avery).
Figure 18. Artificially cut road section into Langebaan Formation calcrete and diorite bedrock, which revealed 3.6 m of Middle Stone Age archaeological deposits at Ysterfontein 1 (photo by G Avery).

Figure 19. Ysterfontein 1 excavation of deeply stratified Middle Stone Age shell middens in rock shelter in Langebaan Formation aeolianites (photo by G Avery).
Appendix 2

Abbreviated Curriculum Vitae: Graham Avery

Contact Details
Home Address: 25 San Bernardo
18 De Lorentz Street
Upper Gardens
Cape Town 8001

Business Details
Graham Avery (Sole Proprietor): Archaeozoology, Stone Age Archaeology and Quaternary Palaeontology.
Telephone: (021) 4241285 (H)
Cell: 083 441 0028
Email: gavery@iziko.org.za; drgavery97@gmail.com

Professional Qualifications
I have worked extensively in the Quaternary palaeontological field, focusing on the south-western coast of South Africa, in both research and commercial contexts. I have conducted research on a variety of Early, Middle and Later Stone Age and palaeontological sites and published the findings.

I am a member of the Palaeontological Society of South Africa and accredited with the Association of Southern African Professional Archaeologists (ASAPA) CRM section (Member #008, 1998) as Principal Investigator: Stone Age, Shell Middens, Middle Pleistocene studies and Archaeozoology.

- PhD (archaeology) 1990 Archaeological and palaeoenvironmental interpretation of avian remains from archaeological sites. University of Cape Town.

Current Positions
- Research Associate Natural History Collections Department, Cenozoic Studies, Iziko South African Museum (April 2012–).
- Research Associate, Archaeology Department, University of Cape Town (July 2012–).

Positions Held
- Retired from Iziko Museums of South Africa 31 January 2012.
- Archaeozoologist, Curator of Quaternary Collections, Cenozoic Studies Section, Natural History Department, Iziko South African Museum (2002–January 2012). [Moved to Natural History Collections Department when Iziko came into being].
- Head of Archaeology Department, South African Museum (1990–1993).
- Researcher, Archaeology Department, South African Museum (1980–2002).
Research Interests (publications not listed here)

- The Late Quaternary palaeoecology of south-western Africa covering material from the Pliocene to the Holocene: Archaeozoological studies—mammals, birds and molluscs in the palaeo-ecological and human history of South Africa;
- Experimental and comparative actualistic studies—taphonomy of human and non-human bone accumulations resulting from carnivores, scavengers and raptors, such as hyaenas, jackals, leopards, eagles and the larger owls. These include a 29-year long-term project monitoring beached birds and mammals;
- Past climates and environments using evidence from birds and mammals (including pollens from hyaena coprolites); and
- The application of archaeozoological and palaeontological research to modern issues of global change, conservation, heritage resource management and education.

Membership of Professionally-Related Societies

- Association of Southern African Professional Archaeologists (ASAPA). Professional Member #008 with Cultural Resource Management (CRM) accreditation.
- South African Society for Quaternary Research (SASQUA).
- Palaeontological Society of South Africa.
- South African Archaeological Society.
- Southern African Museums Association (SAMA) (Life Member).

Cultural Resource Management Experience (CRM)

90 palaeontological and archaeological assessment reports have been conducted, in the western part of the Western Cape Province and 4 on the west coast of the Northern Cape. The focus has been primarily on Late Cenozoic Pleistocene and Holocene occurrences.