Palaeontological Assessment: Proposed Sand and Calcrete Borrow Pit (BP#4: DMR WC30/5/1/3/2/ 10168MP), Farm Anyskop, Rem. 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)

May 2018
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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 Borrow Pit #4 DMR Ref: WC30/5/1/3/2/ 10168MP on Farm Langeberg 188, Vredenburg.

Proposed activity: Mining permit for sand and weathered calcrete Borrow Pit.

Location: Anyskop Farm, Remainder farm Langeberg 188 Borrow Pit #4 DMR Ref: WC30/5/1/3/2/ 10168MP, Vredenburg District.

The proposed sand and calcrete borrow pit 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 and will reach a depth of up to 4 - 5 m.

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 Springfontyn Formation 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 the 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 cover sands do have palaeontological potential as indicated by recent finds, 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 Borrow Pit #1 DMR 10122MP. Other recent palaeontological finds have been recorded in test pits for Pit #4 and the Greenfields Link Cutting.

During mining, fossil finds may be encountered in the Langebaan Formation calcrete/calc-sands. Terrestrial molluscs (Trigonephrus globulus) are likely to occur sporadically throughout the area and are of very 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 at the erosional surface between the light-grey to pale-red sandy soil of the Springfontyn Formation and the calcareous aeolianites of 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 in the Langebaan Formation 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 will be required to deal with any palaeontological or archaeological occurrence. The Workplan Approval and 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, which must be initiated at the same time that mining begins. Prior to mining a training session for staff, including machine operators, is recommended.

Provided that the recommendations in this report are followed, there is no reason why establishment of the proposed sand and calcrite mine should not proceed.
Palaeontological Assessment: Proposed Establishment of a sand and calcrete mine, Farm Anyskop, Remainder Farm Langeberg 188 Borrow Pit#4 DMR Ref: WC30/5/1/3/2/10168MP, 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 Borrow Pit#4 DMR WC30/5/1/3/2/10168MP, Vredenburg (1:50 000 3218CA & CC Velddrif) (Figures 1, 2 and 3).

Figure 1. Approximate location (blue star) of the proposed calcareous sand mine (Borrow Pit#4 DMR Ref: WC30/5/1/3/2/10168MP) on remainder Langeberg 188, 1:50 000 3218CA & CC Velddrif.
Figure 2. Location of proposed sand mine (orange polygon) Borrow Pit#4 DMR Ref: WC30/5/1/3/2/ 10168MP on remainder of Langeberg 188; Location of Borrow pits #1 to #4 are shown and the old borrow pits are arrowed.
Figure 3. Surface of proposed Borrow Pit#4 DMR Ref: WC30/5/1/3/2/ 10168MP. a) View towards north showing sparse vegetation cover on old ploughed light-grey to pale-red sandy soil of the Springfontyn Formation and test pit spoil heaps comprising calcareous Langebaan Formation sand (Photo by G Avery); and b) View roughly east showing sparse vegetation on old ploughed light-grey to pale-red sandy soil of the Springfontyn Formation.
cover sand with Langebaan Formation calcrete clasts (Photo by G Avery) (Also see Figures 6, 7).

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 Borrow Pit#4 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 1997a, b; Roberts and Brink 2002; Pether 2013 a, b, c; Pether, Roberts, and Ward 2000; Almond 2012; Avery in prep., 2018a, b, c) were consulted for background geological and palaeontological information. Since little is known about the sub-surface palaeontological potential of the Borrow Pit#4 locality, literature describing known palaeontological sites in the region was consulted. Observations from Borrow Pits#1 to 3 and test holes on Pit#4 (Avery 2018a, b, c; Orton 2018, and G Avery personal observations on Borrow Pit#4 and two old borrow pits) have been incorporated.

Other than the test holes, the Borrow Pit#4 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 (Figure 3).

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; Figures 4, 5, 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 being 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 (Figure 6) be preserved fossiliferous sediments, including Pleistocene stone artefacts may occur within the projected 4-5 m 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 relevant to this mining application. G3 = Cape Granite Suite coarse granite) (see Figure 3). The proposed Borrow Pit#3 DMR WC30/5/1/3/2/10167MP 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. 2009) and G Avery (pers. observation). Ma = Million years ago; ka = Thousand years ago. Formations relevant to Pit#4 DMR Ref: WC30/5/1/3/2/ 10168MP 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 cordon (&lt;-12 ka)</td>
<td>Rare sub-fossils of importance for historical faunal 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 aeolainites &lt;3 Ma</td>
<td>Mineralized bones moderately common. Local to high significance. Extends under sea. Local to high significance</td>
</tr>
<tr>
<td>Velddrif</td>
<td>Quaternary raised beaches and estuarine deposits &lt;1.2 Ma. Sea levels below -15 m asl</td>
<td>Marine molluscus common and rare bones at or near the coast. High significance</td>
</tr>
<tr>
<td></td>
<td><strong>Marine erosion surfaces below ~15 m asl</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Old indet. sands</strong></td>
<td></td>
</tr>
<tr>
<td>Langebaan</td>
<td>Late Pliocene to mid-Quaternary aeolainites. &lt;3 Ma</td>
<td>Molluscs and sparse (can be patchy concentrations, e.g. Langebaanweg, bones of terrestrial and marine forms. Extends under sea. Local to high significance</td>
</tr>
<tr>
<td>Uylekraal --</td>
<td>Previously subsumed in the upper Varswater Fm</td>
<td>Shell fossils common, local significance. Fossil bones very sparse, high significance</td>
</tr>
<tr>
<td></td>
<td><strong>Marine erosion surface to ~35 m asl</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Old indet. sands</strong></td>
<td></td>
</tr>
<tr>
<td>Langebaan</td>
<td>Earlier Pliocene aeolainites &lt;3 Ma</td>
<td>Fossil bones moderately common, local to high significance.</td>
</tr>
<tr>
<td>Varswater – upper</td>
<td>Later early Pliocene regressive deposits of wider area. 5-4 Ma. Sea-level max. ~50-60 m asl</td>
<td>Fossil bone rare, high significance. Poorly known, fossil shells of high significance</td>
</tr>
<tr>
<td>Varswater – lower</td>
<td>Early Pliocene transgressive marine deposits in embayments (upper KGM?, LQBM and MPFM members</td>
<td>Fossil bone common locally, high significance. Shells very sparse, high significance</td>
</tr>
<tr>
<td></td>
<td><strong>Marine erosion surface to ~60 m asl</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Very old indet. sands</strong></td>
<td></td>
</tr>
<tr>
<td>Prospect Hill</td>
<td>Miocene aeolainite 12 to 9 Ma</td>
<td>Fossils very sparse – high significance</td>
</tr>
<tr>
<td>Saldanha</td>
<td>Mid-Miocene marine deposits (predicted presence), 17-14 Ma. Sea-level max. ~90 m asl. May include the lower KGM?</td>
<td>Very few fossils recovered, high significance if found.</td>
</tr>
<tr>
<td></td>
<td><strong>Marine erosion surface to ~100 m asl</strong></td>
<td></td>
</tr>
<tr>
<td>Langenheim Clayey Sand -- Previously a member of the Lower Varswater Fm</td>
<td>Mid-Miocene early-transgression estuarine deposits (prev. LQSM Member in lower Varswater Fm), 18-17 Ma.</td>
<td>Plant microfossils – high significance</td>
</tr>
<tr>
<td>Elandsfontyn</td>
<td>Middle to late Miocene fluvial coarse, angular sands, muds and carbonaceous sediments. ~15 Ma to ~12 Ma</td>
<td>Microfossils, including pollen, and macro remains of plants, high significance</td>
</tr>
</tbody>
</table>

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed Pit#4 DMR ref: WC30/5/1/3/2/ 10168MP
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 (Formations off interest are arrowed) 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 site in West Coast Fossil Park (LBW) (Figure 2, Table 1) and Elandsfontein (in Table 2).
Figure 6. Wall of old calcrete borrow pit adjacent to Pit#4 showing thin (~0.5 m) light-grey to pale-red Springfontyn Formation cover soil (arrowed) overlying the calcareous Langebaan Formation erosional surface. Pale-grey to light-red material shown above the Springfontyn surface and below the calcrete is spoil not in situ (photo by G Avery).

Figure 7. Langeberg 188 Pit#4. Test hole 5, the spoil heap of which yielded *Chersine angulata* fragments. Note the shallow light-grey to pale red Springfontyn cover soil on the Langebaan Formation erosional surface, which is typical of the local stratigraphy (Photo by G Avery).
Known Sites in the Area

A test hole spoil heap on Pit#4 revealed angulate tortoise *Chersine angulata* and mammal fragments (Figure 8); other than that, a fossil record for the proposed Borrow Pit#4 locality does not currently exist. However, nearby Borrow pit #1 (Orton 2018, Avery 2018c), and the Greenfields Link Cutting excavations have yielded sparse fossils from the Langebaan Formation (Avery, 2018d, Avery in prep.). Sufficient information is available to make at least general comments on what may be encountered in the Springfontyn and Langebaan Formations (Figures 2-9, Tables 1 and 2).

Although there are rare exceptions, such as the Late Pleistocene brown hyaena den accumulations and MSA occurrences in erosional cavities in the Langebaan Formation at Besaansklip (Brink 2005), Sea Harvest (Grine and Klein 1993; Volman 1978), Hoedjiespunt (Klein 1983; Berger and Parkington 1995; Stynder 1997; Will et al. 2013) and recently discovered new occurrences (GMC) at Saldanha Bay Harbour (G Avery pers. obs.) in which large numbers of vertebrate bones, including extinct species, are preserved, palaeontological and Pleistocene archaeological remains in the Springfontyn and Langebaan Formations are more likely to be sporadically and/or sparsely distributed in patches or as isolated items unless a palaeo-feature, such as the water sources in the Springfontyn Formation at Elandsfontein, attracted numbers of animals and people.

Palaeontological remains are widely, but sparsely distributed throughout the Langebaan Formation (Figure 9; Table 2; Pether 2010, 2009).

![Figure 8. Langeberg 188 Pit#4. *Chersine angulata* carapace and mammal fragments from the Langeberg 188 Langebaan Formation sediments on the Test Hole 5 (GA’s numbering) spoil heap.](image)

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed P#4 DMR ref: WC30/5/1/3/2/ 10168MP
Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed Pit#4 DMR ref: WC30/5/1/3/2/ 10168MP

Figure 9. Location of known palaeontological sites associated with the Langebaan Formation near the proposed Borrow Pit#4 (details in Table 2).

Recent monitoring of Pit#1 DMR10122MP revealed a 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 calcrete found by J Orton (Figure 10; Orton 2018).

Figure 10. Mandible of *Mystromys albicaudatus* (scale in cm) recovered by J Orton in the mined area of Borrow Pit #1 DMR 10122MP (Orton 2018). Note the calcareous encrustation indicating its origin in the calcareous Langebaan Formation deposits being mined (Photo by J Orton).
Three stone artefacts, probably of the Middle Pleistocene Early Stone Age, were exposed in Borrow Pit#1 DMR 10122MP on the Springfontyn/Langebaan Formation erosional surface. (Figure 11; Avery 2018b).

![Stone artefacts from the Springfontyn-/Langebaan Formation erosional surface in Borrow Pit#1 DMR 10122MP (30 cm ruler as scale). (Photos G Avery).](image)

A complete angulate tortoise was exposed during excavation of the Greenfields Link Cutting (Figure 12, Avery 2018d).
Figure 12. Complete *Chersine angulata* carapace in Langebaan Formation of the Greenfields Link Cutting (Photo by G Avery).

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>
</tr>
</thead>
<tbody>
<tr>
<td>Eensaamheid – Wind Farm proposal</td>
<td>Langebaan</td>
<td>(Avery and Avery 2009)</td>
<td>Palaeontology. Fossil gastropod <em>Trigonephrus globulus</em> on exposed erosional surface of Langebaan Formation.</td>
<td>Ens</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>
<tr>
<td>Elandsfontein – “Main” Site</td>
<td>Springfontein; Langebaan;</td>
<td>(Archer 2010; Avery 1988, 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; Luyt, Lee-Thorp, and Avery 2000; Roberts and Braun 2014; Smith and Stynder 2015; Stynder 2009; Singer and Wymer 1968; Rogers 1980; Drennan 1953, 1954; Klein 2009; Volman 1984; Goodwin 1953)</td>
<td>Palaeontological and Pleistocene Archaeological. Mainly lower and middle Pleistocene. 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 palaeo-landscape, which included wetlands.</td>
<td>EFT Main (east of area figured)</td>
</tr>
<tr>
<td>Elandsfontein – Wes and surrounds</td>
<td>Springfontein; Langebaan erosion surface</td>
<td>(Mabbutt 1956; Singer and Wymer 1968; Orton 2007; Roberts and Braun 2014; Plasket 2013; Avery 2015, in prep; Goodwin 1953; Halkett and Webley 2015)</td>
<td>Palaeontology and Pleistocene archaeology. Middle Pleistocene. Collected previously. Sparsely scattered mineralized bones, rare stone artefacts,</td>
<td>EFTW (east of area figured)</td>
</tr>
<tr>
<td>Greenfields Link – Cutting</td>
<td>Langebaan</td>
<td>Avery 2018d</td>
<td>Palaeontological. ? Middle Pleistocene. Isolated terrestrial <em>Chersine angulata</em> carapace.</td>
<td>GFC</td>
</tr>
<tr>
<td>Hoedjiespunt – human</td>
<td>Springfontein on Langebaan</td>
<td>(Woodborne 2000; Kyriacou et al. 2015; Stynder et al. 2001; Stynder 1997; Will et al. 2013)</td>
<td>Archaeological. Late Pleistocene. Middle Stone Age artefacts associated with shell midden, which includes terrestrial and marine vertebrate taxa.</td>
<td>HDP1</td>
</tr>
<tr>
<td>Langebaanweg – E Quarry Calc</td>
<td>Langebaan</td>
<td>(Hendey 1974; Hendey 1981, 1982; Roberts et al. 2011)</td>
<td>Palaeontological. West Coast Fossil Park National Heritage Site. Lower Pleistocene (2 Ma to 3 Ma) Langebaan Formation is part of overburden removed during mining to access phosphate-rich deposits. Terrestrial vertebrate taxa and <em>Trigonephris globulus</em>.</td>
<td>LBWcal</td>
</tr>
<tr>
<td>Site</td>
<td>Formation</td>
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<td>Type of Occurrence</td>
<td>Acronym</td>
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<tr>
<td>Langebaanweg – Anyskop</td>
<td>Springfontyn on Langebaan</td>
<td>(Dietl, Kandel, and Conard 2005; Conard 2001a, 2001b, 2002)</td>
<td>Palaeontological and Archaeological. Middle and Late Pleistocene. Early Stone Age (ESA) artefacts – Late Acheulean – and Middle Stone Age – Howiesons Poort.</td>
<td>Akop</td>
</tr>
<tr>
<td>Langeberg 188 Pit#1 DMR 10122MP – human</td>
<td>Springfontyn on Langebaan</td>
<td>Avery 2016, Avery 2018b in prep.</td>
<td>Archaeological. Middle Pleistocene. Three Early Stone Age stone artefacts, at erosional interface between Springfontyn and Langebaan Formations.</td>
<td>L188</td>
</tr>
<tr>
<td>Langeberg 188 Pit#1 DMR 10122MP – fauna</td>
<td>Langebaan</td>
<td>Avery 2016, Orton2018; Avery 2018c</td>
<td>Palaeontological. Sparse mammal and reptile bones, including Mystromys albicaudatus, Bathyergus 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#4</td>
<td>Langebaan</td>
<td>(G Avery Pers. observation)</td>
<td>Palaeontological. A few carapace fragments of Chersine angulata in one of 8 test holes.</td>
<td></td>
</tr>
<tr>
<td>Namaqua Sands Smelter</td>
<td>Langebaan</td>
<td>(Pether 2006)</td>
<td>Palaeontology. Bones, from Langebaan Formation noted in nearby borrow pit.</td>
<td>NS</td>
</tr>
<tr>
<td>Saldanha Harbour GMC1 – hyaena</td>
<td>Springfontyn in Langebaan</td>
<td>(G Avery pers. observation)</td>
<td>Palaeontological. ? Late Pleistocene. Significant brown hyaena den with terrestrial and marine taxa and modern Homo sapiens remains. In cavities eroded into the Langebaan Formation. rhizoliths (root castes) and Trigonephrus globulus in aeolianites.</td>
<td>GMC1</td>
</tr>
<tr>
<td>Saldanha Harbour GMC3&amp;4 – hyaena</td>
<td>Springfontyn in Langebaan</td>
<td>Avery pers. observ.</td>
<td>Palaeontological. ? Late Pleistocene. Significant brown hyaena den with terrestrial and marine taxa and modern Homo sapiens remains. In cavities eroded into the Langebaan Formation. rhizoliths (root castes) and Trigonephrus globulus in aeolianites.</td>
<td>GMC 3&amp;4</td>
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<tr>
<td>Site</td>
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<tr>
<td>Saldanha Harbour Sea Harvest – human</td>
<td>Springfontyn in Langebaan</td>
<td>(Grine and Klein 1993; Volman 1978; Butzer 2004)</td>
<td>Archaeological. Late Pleistocene. Middle Stone Age shell midden with adjacent hyaena dens. In eroded Langebaan Formation cavity/overhang.</td>
<td>SH</td>
</tr>
<tr>
<td>Saldanha Steel</td>
<td>Langebaan</td>
<td>(Pether 1995; Roberts 1997b)</td>
<td>Palaeontological. Sub-surface, reached during deep excavation for foundations. Lower Pleistocene. Some terrestrial <em>Trigonephrus globulus</em> in Langebaan Fm.</td>
<td>SS</td>
</tr>
<tr>
<td>Saldanha Yacht Club – Barn Owl</td>
<td>Springfontyn in Langebaan</td>
<td>(Manthi 2002)</td>
<td>Palaeontological. ? Late Pleistocene. Barn Owl roost with micromammal taxa.</td>
<td>YC</td>
</tr>
<tr>
<td>SALKOR</td>
<td>Langebaan</td>
<td>(Pether 2013c)</td>
<td>Palaeontological. ? Late Pleistocene. 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)</td>
<td>Palaeontological. Excavations for crude oil storage encountered a small patch of important middle Pleistocene terrestrial fossils, including an extinct pig.</td>
<td>Srug</td>
</tr>
</tbody>
</table>

**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).

Unless they are in deeply-deflated dune areas, 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. Later Stone Age surface localities have been assessed by Jayson Orton. He observed no obviously-mineralized bones or late Pleistocene stone artefacts on the surface of proposed Borrow Pit#3 DMR Ref: WC30/5/1/3/2/ 10167MP or Pit#4(J Orton pers. comm.).

A feature of the region is the terrestrial sand-dwelling gastropod *Trigonephris globulus*, shells of which are normally sparsely distributed throughout the calcareous aeolianites (Figures 8, 13). They are not considered further.
Proposed Borrow Pit#4 is close to and lithologically similar to Borrow Pit#1 DMR 10122MP (Avery 2016) and the Greenfields Link Cutting; the palaeontological potential of each is almost certainly similar, if not identical.

Tests in the Borrow Pit#4 area yielded sparse tortoise bones (in 1 of 8 holes) and a few *Trigonephrus globulus* (Figure 8) and monitoring of the Greenfields link Cutting (Table 2) yielded an almost complete tortoise from the upper level of the calcrete (G Avery 2018d) (Figure 12). All of the borrow pits are relatively close (between 1.5 km and 2.3 km) to the West Coast Fossil Park, where sparse early Pleistocene non-archaeological palaeontological material exists in the Langebaan Formation calcareous aeolianites there and Late Pleistocene stone artefacts and bone fragments occurred on the Anyskop site on the Middle to Late Pleistocene erosional interface between light-grey to pale-red middle Pleistocene Springfontyn Formation soil and the Plio-Pleistocene calcrete of the Langebaan Formation (Dietl, Kandel, and Conard 2005; Table 2). Although isolated Stone Age artefacts were exposed on the Springfontyn-/Langebaan Formation erosional surface in Borrow Pit#1, no middle or late Pleistocene archaeological material was encountered at the Greenfields Cutting site (Avery 2018d) or the Pit#4 test holes. It is predicted that such occurrences will be sparsely distributed as patches where water attracted animals and people.

Monitoring of spoil heaps at Borrow Pit#1 DMR 10122MP yielded a few fossil mammal bones, including the jaw of a white-tailed rat *Mystromys albicaudatus* (Figure 10, Orton 2018), with calcareous encrustations of the Langebaan Formation; in addition, three stone artefacts (Figure 11, Avery 2018b.) were observed on the cleared erosional surface of the Springfontyn-/Langebaan Formations. It is, therefore, emphasized that the appointed monitor should be notified of the date excavation is to start and that monitoring is initiated.
at the same time. A Workplan Approval must also be in place to facilitate dealing with possible finds.

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 cavity with bone infill is encountered, or palaeontological and/or Pleistocene archaeological remains exist on the erosion surface or within the Langebaan Formation. Old calcareous-sand borrow pits excavated by the land owner were also investigated (during monitoring of Borrow Pit#1 DMR 10122MP). In these, Light -grey to pale-red sediments of the Springfontyn Formation that overlie the erosional surface of the calcareous Langebaan Formation deposits west of future Pit#4 DMR WC30/5/1/3/2/ 10168MP and north east of Pit#3 are not as deep (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 Borrow Pits’ exposed sections, which are immediately west of Borrow Pit#4.

With respect to Pit#2 DMR 10161MP, the greater depth of Springfontyn Formation sand reported from a geotech test hole (GEOSS 2018) and the test holes in Borrow Pit#4 DMR WC30/5/1/3/2/ 10168MP (G Avery pers. observation) may increase the potential for encountering preserved Pleistocene stone artefacts and/or fossil bones, particularly if the surface of the Langebaan Formation there was less affected by ploughing or erosion.

The sub-surface palaeontological potential can, however, only be more accurately-assessed once mining is initiated; but it is entirely possible (Table 2; Appendix 1: Figures 14 to 19; Orton (2018); Avery (2018 a, b, c) that excavations into sediments not normally accessible to palaeontologists, particularly in the Langebaan Formation, will encounter sporadic palaeontological and Pleistocene archaeological remains as has been the case in Borrow Pit #1 DMR 10122MP. Rather than treating this as a negative, appropriate management can 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, Pit#4 DMR Ref: WC30/5/1/3/2/ 10168MP and the Greenfields Cutting, 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 sandy and calcareous 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.**

<table>
<thead>
<tr>
<th>Potential impacts on palaeontological and Pleistocene archaeological resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of impact:</td>
</tr>
<tr>
<td>Extent of impact:</td>
</tr>
</tbody>
</table>

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed Pit#4 DMR ref: WC30/5/1/3/2/ 10168MP
Consequences of impact: | Medium to high  
---|---  
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 to minimal

**Conclusion**

The mining operation will bring otherwise inaccessible sediment to the surface, which will provide an opportunity(s) to investigate the nature of the sub-surface sediments of the area and will complement sedimentological and distributional knowledge of fossil occurrences found in other localities, such as Langebaanweg (West Coast Fossil Park) (Roberts et al. 2011) and Saldanha Steel (Roberts 1997b).

- Proposed Borrow Pit#4 is close to and lithologically similar to Borrow Pit#1 DMR 10122MP (Avery 2016) and the Greenfields Link Cutting; the palaeontological potential of each is almost certainly similar, if not identical.
- The project offers opportunities to recover important sub-surface palaeontological and, possibly, yet to be encountered, archaeological material, which will be available for future research.
- Recovery of any heritage resources will involve protocols already established to record information and collect material; should it become appropriate archaeological-style excavation will be undertaken.
- 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 and contexts, 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 limited fossil evidence is available for Langeberg 188 Pit#4, it is evident from Borrow Pit#1 DMR 10122MP, the Borrow Pit#4 DMR Ref: WC30/5/1/3/2/ 10168MP test
holes, the Greenfields Link Cutting and regional observations, that this does not mean that potential is lacking in the Langebaan and Springfontyn Formations here and elsewhere.

- Mining should be monitored by a palaeontologist or archaeologist with appropriate palaeontological knowledge. To facilitate monitoring and recovery of any palaeontological resources encountered, a Workplan Approval, outlining methods and protocols to be followed, must be submitted and accepted by HWC prior to mining being initiated. Monitoring must start at the same time as mining and the subsequent frequency of this will 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.

- It is noted that, since the focus of the mining operation is aimed at Langebaan Formation calcareous sand, earlier deposits that underlie this, will not be affected by the mining.

- Provided that the recommendations in this report are followed, current information indicates that the proposed sand mine Borrow Pit#4 will not impact significantly on palaeontological remains; since, 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 resources and possible further mitigation must be included in the Environmental Management Plan (EMP) and the Workplan Approval.

2. A training session to familiarize contractor’s staff, including machine operators, should be undertaken. The author of this report can assist with this.

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

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

**Palaeontological Points for EMP**

• 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 to be undertaken.

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 will be minimized by the appointed specialist obtaining such approval before mining is initiated.

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Appendix 1

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

Figure 14. The Besaansklip locality with brown hyaena den accumulation within cavities in older Langebaan Formation calcrete (photo by JS Brink).

Figure 15. Besaansklip brown hyaena Den. A group of fossil bones in a cavity in older Langebaan Formation calcrete (photo by JS Brink).
Figure 16. Besaansklip excavation showing cavities in older calcrete after removal of bones from access routes/sunning areas (photo by JS Brink).

Figure 17. Langebaan Formation at Sea Harvest showing the kind of overhang/cavity (arrowed) in which brown hyaenas accumulated bones (photo by G Avery). The two small cavities hold bones accumulated by the hyaenas.
Figure 18. 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
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Business Details
Graham Avery (Sole Proprietor): Archaeozoology, Stone Age Archaeology and Quaternary Palaeontology.
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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

Graham Avery Anyskop, remainder Langeberg 188 sand mine proposed P#4 DMR ref: WC30/5/1/3/2/ 10168MP
#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)**

Over 90 palaeontological and archaeological assessments have been conducted, in the western part of the Western Cape Province and 4 on the west coast of the Northern Cape.

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