

Annex 40.3

Cherry Cobb Sands
Geoarchaeological Appraisal

*(Allen Environmental
Archaeology)*

Cherry Cobb Sands, Paull, Humber Estuary (ACW 283); geoarchaeological appraisal

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Michael J. Allen

1 Aims and Scope

1.1 This report provides a basic geoarchaeological record of the upper stratigraphy (4m) of the Cherry Cobb Sands, Paull and outlines the geoarchaeological and palaeo-environmental potential of these deposits. The upper stratigraphy is placed into context by examination of geotechnical cone penetration records to 25m depth.

1.2 The aims of the geoarchaeological assessment were to record the Holocene sediments record with a view to assessing their palaeo-environmental and geoarchaeological potential, and indirectly to define if the deposits had the potential to mask, bury, seal or contain buried land surfaces, or significant evidence of archaeological activity (cf. Allen 1991; Needham & Macklin 1992).

1.3 This appraisal concentrates on the upper 4m (exposed in trial pits), as the development impact is expected to be down to about 1m, and no more than 1.5m.

2 Location

2.1 Cherry Cobb Sands, Paull, East Riding of Yorkshire, lies on the Northern Humber Estuary shore about 5km southeast of Hull. The site of Cherry Cobb Sands under investigation is an area of approximately 186ha of coastal plain and comprises of a strip of reclaimed land *c.* 3.5km long and up to *c.* 0.8km wide below 2-3m OD (Chandler *et al.* 2010). This area lies adjacent to a former sand island called Sunk Island (Chandler *et al.* 2010; Van de Noort & Ellis 1995).

3 Methods and limitations

3.1 A series of 14 geotechnical trial pits and 12 piezo cone penetration tests was undertaken by Delta-Simons Environmental Consultants and In Situ Site Investigations across the area (Fig. 1). The geotechnical trial pits were excavated under archaeological supervision and archaeological records were made of each trial pit by Chris Caine of AC Archaeology Ltd. Bulk samples of *c.* 10 - 15 litres of disturbed sediment was removed from every layer except the topsoil. The archaeological records of deposits from the trial pits were augmented by geoarchaeological description of a selection of the bulk samples retained at AC Archaeology Offices (Appendix 3). Some 67% (18 of 27) of the samples were examined and described, representing 9 of the 13 pits sampled (69%). Sedimentological description followed standard

notation outlined by Hodgson (1976). The disturbed bulk samples did not, however, allow for record of pedological structure or fine sedimentary architecture such as laminations, tidal couplets, etc. Those samples that were examined were also visually inspected for the potential of waterlogging and the presence of waterlogged plant and organic remains. These data were compared with the geotechnical records supplied by Delta-Simons Environmental Consultants and enabled the compilation of a basic sedimentological record for the upper 4m (Appendix 1). Two profiles were created; one for the shoreward sediments (North-eastern transect A-B) and seaward sediments (south-western transect C-D) see Figs. 1, 3 and 4.

3.2 To provide a broader context for this sedimentary sequence, the deeper geotechnical records of the piezo cone penetration tests to 18 and 25m were reviewed (Appendix 2) and these data have been used in the profile transects (Figs. 3 and 4).

3.3 One 2 litre subsample was removed from each of four disturbed samples, for processing by laboratory bucket washover flotation, and for sieving to examine the presence of palaeo-environmental macrofossils (samples are listed in Appendix 3). Flots were retained on 0.5mm mesh and the residues fractionated into 1mm, 2mm and 4mm fractions.

4 Setting: Geology, Topography and Palaeo-environmental Potential

4.1 The bed rock is Cretaceous chalk, gently dipping to the Northeast, which in the area of Holderness and Humber estuary is deeply buried by considerable Quaternary deposits reaching 30m thickness in some areas. These deposits are predominantly glacial till and glacio-fluvial material (Van de Noort & Ellis 1995) deposited toward the end of the Devensian period (last glaciation) at around 18,000 BP (Penny *et al.* 1969). The Skipsea Till is the main unit underlying the study area which is a glacially reworked marine sediments (clays and sands). Superficial to the Till are locally extensive melt water deposits of mainly sands and gravels and alluvium. The area of the current investigation is mapped as alluvium and today supports brown earths and surface water gley soils.

4.2 The Holocene record is fragmentary and locally complex as a result of rising sea levels (Long *et al.* 1998; Dinnin & Lillie 1995a) and the constantly changing dynamic deposition and erosional environments. These include rapid sea-level rise in the early Holocene (*c.* 8500 BC), and large land inundation around 1250 BC as a result of further rapid sea level rise. A complex history of estuarine and riverine development is recorded in the Humber estuary itself, which includes the development and movement of a large sand bar within the Humber estuary west and Northwest of the study area (Paul Sand and Foul Holme Sand), the former sand island of Cherry Cobb Sands itself and Sunk Island; summarised by Chandler *et al.* (2010).

4.3 The area was formerly intertidal saltmarsh with a number of small dendritic estuary-margin creeks draining into the Humber and was probably intermittently or permanently inundated until the 18th century when Cherry Cobb Sands themselves began to form. After

1799 the area was protected by a seawall and reclaimed, and today is dry good agricultural land.

5 Geoarchaeological and Palaeo-environmental potential

5.1 The changing Humber estuary has, therefore, the potential to preserve buried land surfaces, seal deposits of archaeological significance and contain sedimentary sequences with stratified palaeo-environmental records. Long Holocene pollen and sedimentary sequences have been recorded in studies in Holderness, to the North of the study area (Dinnin & Lillie 1995a; 1995b; Taylor 1995).

6 Geoarchaeological Record

6.1 The geoarchaeological record for the upper 4m as defined by the trial pit record is outlined below, and then placed in the context of the deeper stratigraphic sequence of 18-25m.

Superficial deposits (the upper 4m)

6.2 The sediment across the 14 trial pits were recorded (Appendix 1) and three distinct sediment units were recognised (Fig. 2).

Unit 1 'brown silty sand': brown to dark yellowish brown (10YR 4/3 – 4/4) homogenous loose stone-free well-sorted silty sand, to silty sand loam

Unit 2 'grey coarse silt': very dark grey to black (10YR 3/1 -2/1) massive stone-free well-sorted coarse silt to silty sand, oxidising to dark yellowish brown (10YR 4/2)

Unit 3 'grey sandy silt': greyish brown (10YR 5/2) loose stone-free well-sorted fine sandy silt

6.3 Units 1 and 2 were ubiquitous, with unit 1 uniformly recorded to a depth of 1.55 to 2.15m. Unit 2 generally extended beyond a depth of 4m (the maximum extent of the trial pits), but its base and contact with unit 3 was recorded at 3.1m and 3.4m in trial pits 1 and 3 respectively (Table 1). Both deposits when examined in disturbed state, were non-cohesive, non-organic deposits. The dark colours of units 2 and 3 result from mineral colour, not humic or organic matter. These are well-sorted and are essentially fluvially reworked fluvio marine and glacio-fluvio marine, estuarine sands.

6.4 These are accretionary depositional sequences, and no buried soils nor evidence of former *in situ* land surfaces were recorded. The deposits are generally sands, or fine sands and silts, indicating moderate depositional energy. No fine grained deposits were encountered in the upper 4m.

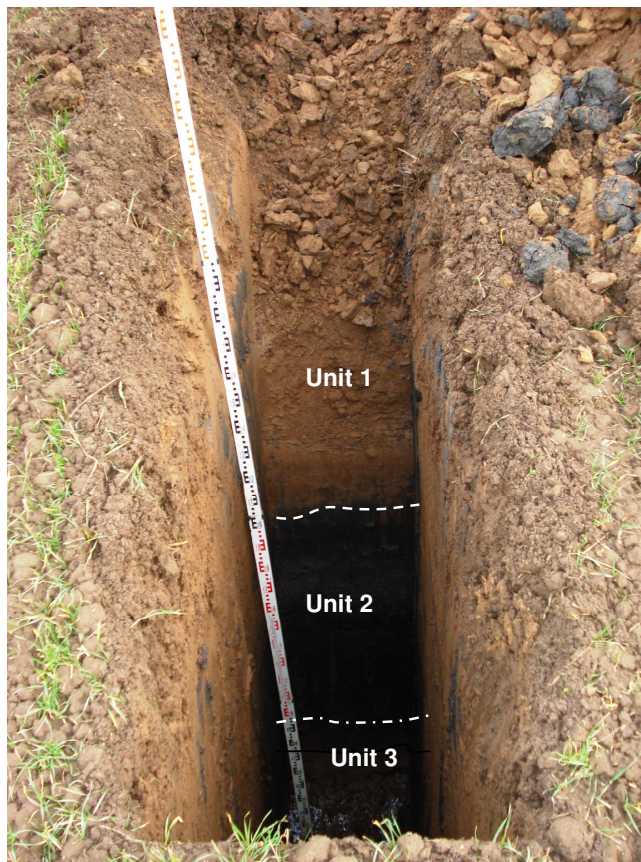


Fig. 2: Trial Pit TP1 (photo: Chris Caine, AC Archaeology Ltd.)

| Trial pit | Depth to | | |
|------------------|-----------------------|-----------------------|-----------------------|
| | base of unit 1 | base of unit 2 | base of unit 3 |
| TP 1 | 1.8m | 1.8m | >4.0m |
| TP 2 | - | >3.7m | - |
| TP 3 | 1.75m | 3.4m | >4.0m |
| TP 4 | 1.95m | >4.1m | - |
| TP 5 | 2.0m | >3.9m | - |
| TP 6 | 2.0m | >4.0m | - |
| TP 7 | 1.8m | >3.8m | - |
| TP 8 | 1.6m | >4.0m | - |
| TP 9 | 1.9m | >3.9m | - |
| TP 10 | 2.1m | >3.9m | - |
| TP 11 | 1.35m | >2.7m | - |
| TP 12 | - | - | - |
| TP 13 | 1.55m | >3.9m | - |
| TP 14 | 2.15m | >4.0m | - |

Table 1: Depths of sedimentary units as recorded from Trial Pits

6.5 When recorded as profiles (Figs. 3 and 4) the main two units form simple uniform successive blankets of sediment across the entire study area, excepting areas of specific disturbance and contamination (trial pits TP11, TP12). The third deposit (unit 3) is a coarse grained sand which fines upwards indicating a reduction in fluvial and depositional energy over time. Unit 3 was only recorded in trial pits TP1 and TP3 on the south-eastern margins of the study area (Fig. 1).

6.6 Disturbance and earthworks associated with the contaminated deposits in trial pits TP11 and TP12 was recorded during the walk-over survey by AC Archaeology (Cox pers. comm.). The upper portion of trial pit TP2 was reported as a post-medieval field drain.

The deeper stratigraphic context

6.7 This unremarkable inorganic sediment blanket in the upper 4m can be placed into the deeper stratigraphic context by comparison with the deeper records made by In Situ Site Investigations from piezo cone penetration tests to 25m. These are summarised in Appendix 2, and selected records of cone penetration tests adjacent to the transects are illustrated on the sediment profiles in Figs. 3 and 4.

6.8 Superficially, there appears to be disparity between the two sets of records, but this is because the nomenclature and descriptive terms used for geotechnical purposes differs from that used in sedimentary geography. The deposits are, therefore, indicated on the profiles using the sediment conventions employed in the geotechnical record.

6.9 Nevertheless, sands and silts are recorded to depths in excess of 25m with a significantly greater proportion of sand in the south-west transect C-D perhaps indicating a longitudinal sand bar behind which finer, silty clays, silts and sand silts were deposited. The majority of these lower sediments are Quaternary but predate the Holocene (i.e. 10,000 BP). Neither the basal chalk geology, nor the Skipsea Till, seems to have been encountered at these depths. This is in accordance with excavations or boring undertaken in 1799 which reported at least 100ft (c. 30.5m) of alluvial silts above the solid and degraded natural chalk (Chandler *et al.* 2010, 10.3).

6.10 These records show very deep estuarine and marine deposits, of which the upper 4m represent just a small and recent portion. They do indicate a long history of dynamic fluvio-marine sedimentation relating to Humber estuary itself.

7 Palaeo-environmental record

7.1 Four subsamples were taken to rapid test for the presence palaeo-environmental macrofossils to aid in indicating the palaeo-environmental potential of the sequences. All samples were c. 2 litres and were subsampled from the 10-15 large disturbed bulk samples. Samples were taken from the stratigraphic series of deposits (contexts) in trial pit TP1 as

representative of the full sequence. These were from: context 101 (unit 1), context 102, (unit 2) and context 103 (unit 3)

7.2 An additional subsample of context 801 (trial pit TP8, unit 1) was taken to recover and identify shells recorded by the field logs and observed during description.

Stratigraphic sequence

7.3 The flots would have been examined under $\times 10$ - $\times 30$ magnification using a wide-field stereo-binocular microscope, however processing did not produce any flots, excepting small quantities of modern roots. No charred or waterlogged remains were present (Table 2).

7.4 A single sample of 2.2 litres was processed by flotation to recover marine shells. No flot was recorded. The sediment was then sieved to 2mm and the shell valves recovered. Nine valves (MNI 5) of the bivalve mollusc *Tellina* sp. This a common genus often found washed up in the littoral zone along the strand line. The examples recovered were *T. donacina*, *T. pygmaea* or *T. tenuis*; all species living on coarse sand and shell gravel (*T. donacina*, *T. pygmaea*) or fine sand in the middle intertidal zone (*T. tenuis*). All are common around the British Isles and the North-eastern seaboard especially *T. tenuis* (Tebble 1966).

| context | Unit sample | | volume | Flot (0.5mm) | | | Residue (1mm, 2mm & 4mm) | |
|---------|-------------|---|------------|-----------------|----------|-------|--------------------------|------------|
| | | | | Charred remains | Charcoal | other | charcoal | other |
| 101 | 1 | 1 | 2.3 litres | - | - | - | - | - |
| 102 | 2 | 2 | 2.6 litres | - | - | - | - | Shell frag |
| 103 | 3 | 3 | 2.2 litres | - | - | - | - | - |

Table 2: Rapid assessment of the macro-remains from each sedimentary unit

8 Geoarchaeological Interpretation, Significance and Potential

8.1 The base of the deposits recorded in the trial pits (Appendix 1) lies at levels well above the -9m OD known for the Mesolithic land surfaces. The sediments recorded are largely reworked marine and fluvial sands, probably dating to the medieval and post-medieval periods and can be crudely tied to the dynamic and rapidly changing development of the changing river course and bed within Humber estuary.

8.2 The sediments are entirely fluvial and no terrestrial or intertidal contexts have been recovered. There is little potential for the presence of archaeological remains and sites, other than maritime evidence and artefacts, to be present. The deposits are sands indicating moderate energy erosional and depositional environments and thus even any maritime artefacts that could occur may not be well preserved.

8.3 The deposits, as recorded, seem to have low palaeo-environmental and archaeological significance or potential. The sedimentary record does, however have some potential to aid in an understanding off the historic development of the Humber channel and estuary if they can be related more closely to the historical records.

Palaeo-environmental Potential

8.4 No palaeo-environmental macrofossils, except marine shells recorded in one context, were present in the sequences. The deposits are inherently undateable, and they are deemed, on the basis of the historical study (Chandler *et al.* 2010), their sedimentary context, and the nature of the deposits themselves, to be recent; i.e. medieval or post medieval. Although there is the possibility of preserved pollen sequences, the deposits cover relatively short time periods and the lack of any dating potential to provide any chronological markers renders them of low palaeo-environmental significance.

Geoarchaeological Potential

8.5 The potential for further geoarchaeological analysis is low. Nevertheless, the record provided clearly characterises the deposits.

Radiocarbon Potential

8.6 The radiocarbon potential of the deposits and samples examined is nil. There was nothing present that could be dated, and little potential for such being present.

9 Summary and Comment

9.1 Deposits wholly relating to the Humber channel and river bed were recovered. The palaeo-environmental potential of these deposits is considered low, and hindered by the lack of possibility of dating the sequences. The possibility of terrestrial archaeology being present is low, but the possibility of maritime artefacts within and beneath the sediments does, however, exist.

- The deposit sequence was uniform, non-organic and comprised mainly two simple homogenous sediment blankets.
- The 4m of stratigraphy examined largely relate to the relatively high energy erosional and depositional estuarine and channel environments of the Humber River itself.
- The deposits recovered are wholly fluvio-marine or glacio-fluvial and no terrestrial or intertidal contexts were recognised.
- The potential for buried, terrestrial, land surfaces and terrestrial archaeological evidence is low

- No evidence of a former sand island was recognised, although the sands recovered may have formed part of a temporary land form.
- The palaeo-environmental potential for the sequence is low.
- There is only limited geoarchaeological potential, which largely lies in attempting to relate the sediment packets to the historical development of the Humber estuary development and remodelling at Cherry Cobb Sand.

10 Recommendations

10.1 No further work on the samples recovered is deemed necessary.

10.2 The possibility of examining the relationship of the recorded sediments with the historical records could be examined.

11 Acknowledgements

Thanks to Peter Cox (AC Archaeology) for discussion the results of earlier research and of the archaeological walkover survey, and to Sarah Cottam of AC Archaeology for the production of the figures in this report. The archaeological field records were compiled by Chris Caine (AC Archaeology).

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APPENDIX 1

Trial Pit Records (archaeological and geoarchaeological record)

Trial Pit 1

| context | Depth (cm) | Unit samples | | Description |
|----------------|-----------------------|-------------------------|---|--|
| 100 | 0-30 | | | Soil |
| 101 | 30-180 | 1 | 1 | Brown to dark yellowish brown (10YR 4/3 - 4/4) loose stone-free silty sand |
| 102 | 180-310 | 2 | 2 | Very dark grey to black (10YR 3/1 - 2/1) stone-free coarse silt |
| 103 | 310-330 | 3 | 3 | Greyish brown (10YR 5/2) loose stone-free fine sandy silt |
| 103 | -400+ | | | |

Trial Pit 2

| context | Depth (cm) | Unit samples | | Description |
|----------------|-----------------------|-------------------------|---|--|
| 200 | 0-30 | | | Soil |
| 201 | 30-190 | 0 | 4 | Reported as post-medieval field drain |
| 202 | 190-370 | 2 | 5 | AS 102 "Very dark grey to black (10YR 3/1 - 2/1) stone-free coarse silt" |
| 202 | -390+ | | | |

Trial Pit 3

| context | Depth (cm) | Unit samples | | Description |
|----------------|-----------------------|-------------------------|---|---|
| 300 | 0-35 | | | Soil |
| 301 | 35-175 | 1 | 6 | AS 101 "Brown to dark yellowish brown (10YR 4/3 - 4/4) loose stone-free silty sand" |
| 302 | 175-340 | 2 | 7 | AS 102 "Very dark grey to black (10YR 3/1 - 2/1) stone-free coarse silt" |
| 303 | 340-360 | 3 | 8 | AS 103 "Greyish brown (10YR 5/2) loose stone-free fine sandy silt" |
| 303 | -400+ | | | |

Trial Pit 4

| context | Depth (cm) | Unit samples | | Description |
|----------------|-----------------------|-------------------------|----|---|
| 400 | 0-30 | | | Soil |
| 401 | 30-195 | 1 | 9 | AS 101 "Brown to dark yellowish brown (10YR 4/3 - 4/4) loose stone-free silty sand" |
| 402 | 195-280 | 2 | 10 | AS 102 "Very dark grey to black (10YR 3/1 - 2/1) stone-free coarse silt" |
| 402 | -410+ | | | |

Trial Pit 5

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|---|
| 500 | 0-40 | | | Soil |
| 501 | 40-200 | 1 | 11 | AS 101 "Brown to dark yellowish brown (10YR 4/3 - 4/4) loose stone-free silty sand" |
| 502 | 200-290 | 2 | 12 | AS 102 "Very dark grey to black (10YR 3/1 - 2/1) stone-free coarse silt" |
| 502 | -390+ | | | |

Trial Pit 6

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|---|
| 600 | 0-30 | | | Soil |
| 601 | 30-200 | 1 | 13 | Dark greyish brown (10YR 4/2) stone-free silty sand |
| 602 | 200-340 | 2 | 14 | Very dark grey (10YR 3/1) stone-free silty sand, oxidising to dark greyish brown (10YR 4/2) |
| 602 | -400+ | | | |

Trial Pit 7

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|---|
| 700 | 0-25 | | | Soil |
| 701 | 25-180 | 1 | 15 | Dark yellowish brown (10YR 4/4) loose stone-free silty sand |
| 702 | 180-330 | 2 | 16 | Dark greyish brown (10YR 4/2) stone-free coarse silt |
| 702 | -380+ | | | |

Trial Pit 8

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|--|
| 800 | 0-20 | | | Soil |
| 801 | 20-160 | 1 | 17 | Brown (10YR 4/3) stone-free coarse silty sand with marine shells (<i>Tellina</i> spp.) |
| 802 | 160-340 | 2 | 18 | Very dark grey (10YR 3/1) stone-free fine sandy loam (with fine and coarse silt), oxidising to dark greyish brown (10YR 4/2) |
| 802 | -400+ | | | |

Trial Pit 9

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|--|
| 900 | 0-30 | | | Soil |
| 901 | 30-190 | 1 | 19 | Brown (10YR 4/3), stone-free well-sorted coarse silty sand |
| 902 | 190-360 | 2 | 20 | Dark greyish brown (10YR 4/2) stone-free well-sorted coarse silt with very fine sand |
| 902 | -390+ | | | |

Trial Pit 10

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|--|
| 1000 | 0-30 | | | Soil |
| 1001 | 30-210 | 1 | 21 | Dark yellowish brown (10YR 4/4 - 4/6) loose stone-free fine sandy silt |
| 1002 | 210-370 | 2 | 22 | Very dark grey (10YR 3/1) coarse silt (fine sand) oxidising to dark greyish brown (10YR 4/2) |
| 1002 | -390+ | | | |

Trial Pit 11

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|--|
| 1100 | 0-45 | | | Soil |
| 1101 | 45-135 | 0 | | Reported as land fill |
| 1102 | 135-155 | | 23 | Very dark greyish brown to very dark grey (10YR 3/2 – 3/1) humic silt with common fine fleshy medium roots – pungent oily smell – CONTAMINATED |
| 1102 | -210 | 0 | | |
| | -270 | 0 | | DELTA-SIMONS reported as made ground |

Trial Pit 12

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|--|---|
| 1200 | 0-40 | | | Soil |
| 1201 | 40-80 | 0 | | Reported as landfill with asbestos, metal, brick etc. |
| 1202 | -250+ | | | |

Trial Pit 13

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|--|
| 1300 | 0-30 | | | Soil |
| 1301 | 30-155 | 1 | 24 | Brown (10YR 4/3) coarse silt, some fine quartz sand rare fine mottles of dark yellowish brown (10YR 4/6) |
| 1302 | 155-310 | 2 | 25 | Dark greyish brown (10YR 4/2) stone-free coarse silt |
| 1302 | -390+ | | | |

Trial Pit 14

| context | Depth (cm) | Unit samples | | Description |
|----------------|-------------------|---------------------|----|---|
| 1400 | 0-35 | | | Soil |
| 1401 | 35-215 | 1 | 26 | Brown (10YR 4/3) coarse silt |
| 1402 | 215-275 | 2 | 27 | Dark greyish brown (10YR 4/2) stone-free silt (to silty clay) |
| 1402 | -400+ | | | |

APPENDIX 2
Piezo Cone Penetration Record (In situ Site Investigation Ltd)

Piezo Cone penetration record (In Situ Site Investigation) CPT 01

| context | Depth (m) | Unit samples | Description |
|----------------|------------------|---------------------|---|
| | 0-0.9 | | Firm clay CLAY |
| | 0.9-1.2 | | Stiff sandy silt to clayey silt SILT |
| | 1.2-2.6 | | Soft fine grained |
| | 2.6-4.6 | | Firm sandy silt to clayey silt SILT |
| | 4.6-4.9 | | Soft clayey silt to silty clay SILT/CLAY |
| | 4.9-5-1 | | Loose silty sand to sandy silt SAND/SILT |
| | 5.1-6.3 | | Soft fine grained |
| | 6.3-8.2 | | Soft clay CLAY |
| | 8.2-9.0 | | Loose silty sand to sandy silt SAND/SILT |
| | 9.0-9.3 | | Soft clay CLAY |
| | 9.3-15.4+ | | Loose sand to silty sand (clay layers) SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 01A

| context | Depth (m) | Unit samples | description |
|----------------|------------------|---------------------|---|
| | 0-1.1 | | Firm clay CLAY |
| | 1.1-1.4 | | Firm sandy silt to clayey silt SILT |
| | 1.4-2.8 | | Firm clayey silt to silty clay SILT/CLAY |
| | 2.8-3.7 | | Stiff sandy silt to clayey silt SILT |
| | 3.7-4.8 | | Dense silty sand to sandy silt SAND/SILT |
| | 4.8-5.1 | | Firm clayey silt to silty clay SILT/CLAY |
| | 5.1-5.3 | | Loose silty sand to sandy silt SAND / SILT |
| | 5.3-8.6 | | Soft silty clay to clay CLAY |
| | 8.6-9.2 | | Stiff sandy silt to clayey silt SILT |
| | 9.2-9.7 | | Firm clayey silt to silty clay SILT/CLAY |
| | 9.7-10.2 | | Dense sand to silty sand SAND |
| | 10.2-10.6 | | Soft clayey silt to silty clay SILT/CLAY |
| | 10.6-17.0 | | Dense sand to silty sand (clay layers) SAND |
| | 17.0-18.0 | | Stiff sandy silt to clayey silt SILT |
| | 18.0-25.1+ | | Dense sand SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 02

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|--|
| | 0-1.0 | | Firm clay CLAY |
| | 1.0-1.6 | | Loose silty sand to sandy silt SAND/SILT |
| | 1.6-2.8 | | Soft clay (with layers of sand) CLAY |
| | 2.8-6.9 | | Dense sand to silty sand SAND |
| | 6.9-8.4 | | Firm clayey silt to silty clay SILT/CLAY |
| | 8.4-8.75 | | Soft clay CLAY |
| | 8.75-10.1 | | Loose silty sand to sandy silt SAND/SILT |
| | 10.1-10.45 | | Firm clayey silt to silty clay CLAY/SILT |
| | 10.45-11.1 | | Stiff sandy silt to clayey silt SILT |
| | 11.1-12.25 | | Dense sand to silty sand SAND |
| | 12.25-12.8 | | Firm clayey silt to silty clay SILT/CLAY |
| | 12.8-13.7 | | Dense sand SAND |
| | 13.7-15.1 | | Stiff sandy silt to clayey silt (clay layers) SILT |
| | 15.1-16.4 | | Dense sand to silty sand SAND |
| | 16.4-17.5 | | Stiff sandy silt to clayey silt (sand layers) SILT/CLAY |
| | 17.5-18.65+ | | Dense sand SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 03

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|---|
| | 0-0.35 | | Dense sand SAND |
| | 0.35-1.2 | | Stiff clay CLAY |
| | 1.2-1.5 | | Stiff sandy silt to clayey silt SILT |
| | 1.5-2.0 | | Soft silty clay to clay CLAY |
| | 2.0-3.15 | | Fine grained |
| | 3.15-3.35 | | Firm clayey silt to silty clay SILT/CLAY |
| | 3.35-5.2 | | Dense sand SAND |
| | 5.2-5.45 | | Firm clay CLAY |
| | 5.45-11.2 | | Dense sand to silty sand SAND |
| | 11.2-11.8 | | Dense sand SAND |
| | 11.8-12.35 | | Dense sand to silty sand SAND |
| | 12.35-12.5 | | Stiff clay CLAY |
| | 12.5-14.2+ | | Dense sand SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 04

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|---|
| | 0-0.7 | | Soft clay CLAY |
| | 0.7-2.6 | | Firm sand silt to clayey silt SILT |
| | 2.6-7.7 | | Dense sand to sandy silt SAND/SILT |
| | 7.7-8.2 | | Stiff sandy silt to clayey silt SILT |
| | 8.2-9.0 | | Firm clayey silt to silty clay SLT/CLAY |
| | 9.0-9.6 | | Firm sandy silt to clayey silt SILT |
| | 9.6-12.25 | | Loose silty sand to sandy silt SAND/SILT |
| | 12.25-13.85 | | Soft clayey silt to silty clay SILT/CLAY |
| | 13.85-14.7 | | Dense sand to silty sand SAND |
| | 14.7-15.25 | | Firm clayey silt to silty clay SILT/CLAY |
| | 15.25-15.8 | | Loose sand to silty sand SAND |
| | 15.8-17.25 | | Dense sand SAND |
| | 17.25-18.6+ | | Dense sand SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 05

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|--|
| | 0-1.2 | | Stiff clay CLAY |
| | 1.2-2.0 | | Soft clay CLAY |
| | 2.0-3.1 | | Stiff sandy silt to clayey silt SILT |
| | 3.1-4.1 | | Dense silty sand to sandy silt SAND/SILT |
| | 4.1-5.5 | | Stiff sandy silt to clayey silt SILT |
| | 5.5-12.3 | | Dense silty sand to sandy silt SAND/SILT |
| | 12.3-13.6 | | Dense sand to silty sand SAND |
| | 13.6-14.5 | | Stiff clayey silt to silty clay SILT/CLAY |
| | 14.5-15.4 | | Dense sand to silty sand SAND |
| | 14.4-19.85 | | Firm clay CLAY |
| | 19.85-20.05+ | | Dense sand SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 06

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|---|
| | 0-1.1 | | Firm clay CLAY |
| | 1.1-1.8 | | Fine grained |
| | 1.8-4.3 | | Loose silty sand to sandy silt SAND/SILT |
| | 4.3-6.5 | | Dense silty sand to sandy silt (clay layers) SAND/SILT |
| | 6.5-8.5 | | Dense sand to silty sand (clay layers) SAND |
| | 8.5-12.45 | | Dense sand to silty sand SAND |
| | 12.45-12.9 | | Soft clay CLAY |
| | 12.9-13.6 | | Dense sand to silty sand SAND |
| | 13.6-18.2 | | Firm sandy silt to clayey silt SILT |
| | 18.2-19.35 | | Dense sand SAND |
| | 19.35-20.25+ | | Stiff silt to clayey silt SILT |

Piezo Cone penetration record (In Situ Site Investigation) CPT 07

| context | Depth (m) | Unit samples | description | |
|----------------|------------------|-------------------------|---------------------------------|-----------|
| | 0-0.6 | | Dense gravelly sand to sand | SAND |
| | 0.6-2.05 | | Stiff clay | CLAY |
| | 2.05-2.6 | | Loose silty sand to sandy silt | SAND/SILT |
| | 2.6-3.55 | | Firm sandy silt to clayey silt | SILT |
| | 3.55-7.3 | | Dense sand to silty sand | SAND |
| | 7.3-9.8 | | Loose silty sand to sandy silt | SAND/SILT |
| | 9.8-10.2 | | Dense sand to silty sand | SAND |
| | 10.2-10.8 | | Stiff sandy silt to clayey silt | SILT |
| | 10.8-11.2 | | Loose silty sand to sandy silt | SAND/SILT |
| | 11.2-11.6 | | Soft clay | CLAY |
| | 11.6-13.3 | | Dense sand to silty sand | SAND |
| | 13.3-16.4 | | Dense sand to silty sand | SAND |
| | 16.4-17.5 | | Firm clayey silt to silty clay | SILT/CLAY |
| | 17.5-18.9+ | | Dense sand | SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 08

| context | Depth (m) | Unit samples | description | |
|----------------|------------------|-------------------------|--------------------------------------|-----------|
| | 0-0.8 | | Dense sand | SAND |
| | 0.8-2.3 | | Firm clay | CLAY |
| | 2.3-3.1 | | Stiff clayey silt to silty clay | SILT/CLAY |
| | 3.1-4.0 | | Firm clay (sand layer) | CLAY |
| | 4.0-10.0 | | Dense silty sand to sandy silt | SAND/SILT |
| | 10.0-10.6 | | Stiff sandy silt to clayey silt | SILT |
| | 10.6-11.1 | | Firm clay | CLAY |
| | 11.1-11.5 | | Very stiff sandy silt to clayey silt | SILT |
| | 11.5-11.8 | | Soft clay | Clay |
| | 11.8-12.1 | | Dense sand to sandy silt | SILT |
| | 12.1-15.2 | | Soft clay (sand layer) | CLAY |
| | 15.2-16.0 | | Very stiff sandy silt to clayey silt | SILT |
| | 16.0-17.8 | | Dense sand to silty sand | SAND |
| | 17.8-20.0+ | | Dense gravelly sand to sand | SAND |

Piezo Cone penetration record (In Situ Site Investigation) CPT 09

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|--|
| | 0-0.25 | | Firm clay CLAY |
| | 0.25-0.5 | | Dense sand SAND |
| | 0.5-1.35 | | Firm clay CLAY |
| | 1.35-4.8 | | Stiff sandy silt to clayey silt SILT |
| | 4.8-5.7 | | Soft clay CLAY |
| | 5.7-7.5 | | Stiff clay (sand layer) CLAY |
| | 7.5-9.0 | | Very stiff clayey silt to silty clay (sand layer) SILT/CLAY |
| | 9.0-11.35 | | Dense sand to sandy silt SAND/SILT |
| | 11.35-11.7 | | Stiff clayey silt to silty clay SILT/CLAY |
| | 11.7-13.2 | | Soft clay CLAY |
| | 13.2-14.9 | | Dense silty sand to sandy silt (clay layer) SAND/SILT |
| | 14.9-16.0 | | Dense sand SAND |
| | 16.0-20.0+ | | Soft clay CLAY |

Piezo Cone penetration record (In Situ Site Investigation) CPT 10

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|--|
| | 0-0.7 | | Soft clay CLAY |
| | 0.7-1.65 | | Stiff sandy silt to clayey silt SILT |
| | 1.65-5.8 | | Soft sandy silt to sandy silt SILT |
| | 5.8-6.8 | | Stiff sandy silt to clayey silt (sand layer) SILT |
| | 6.8-10.25 | | Dense sand to silty sand (clay layers) SAND |
| | 10.25-11.25 | | Stiff sandy silt to clayey silt SILT |
| | 11.25-14.1 | | Soft clay to clay CLAY |
| | 14.1-14.3 | | Loose silty sand to sandy silt SAND/SILT |
| | 14.3-14.9 | | Firm clayey silt to silty clay SLT CLAY |
| | 14.9-15.2 | | Loose silty sand to sandy silt SAND/SILT |
| | 15.2-15.5 | | Dense sand SAND |
| | 15.5-17.3 | | Stiff silty clay to clay CLAY |
| | 17.3-17.85 | | Dense sand SAND |
| | 17.85-20.1+ | | Stiff silty clay to clay CLAY |

Piezo Cone penetration record (In Situ Site Investigation) CPT 11

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|--|
| | 0-2.8 | | Very soft clay CLAY |
| | 2.8-4.7 | | Fine grained |
| | 4.7-6.8 | | Firm sandy silt to clayey silt SILT |
| | 6.8-9.2 | | Loose sand to silty sand SAND/SILT |
| | 9.2-9.8 | | Stiff silt to clayey silt SILT |
| | 9.8-10.6 | | Dense sand to silty sand SAND |
| | 10.6-12.3 | | Soft clay CLAY |
| | 12.3-14.2 | | Dense sand SAND |
| | 14.2-15.25 | | Stiff silty clay to clay CLAY |
| | 15.25-20.0+ | | Stiff silty clay to clay CLAY |

Piezo Cone penetration record (In Situ Site Investigation) CPT 12

| context | Depth (m) | Unit samples | description |
|----------------|------------------|-------------------------|---|
| | 0-0.9 | | Soft clay CLAY |
| | 0.9-1.85 | | Stiff sandy silt to clayey silt SILT |
| | 1.85-3.25 | | Fine grained |
| | 3.25-5.15 | | Firm sandy silt to clayey silt SILT |
| | 5.15-11.25 | | Dense silty sand to sandy silt SAND/SILT |
| | 11.25-13.5 | | Very stiff clay (sand layer) CLAY |
| | 13.5-14.4 | | Dense sand SAND |
| | 14.4-18.1 | | Stiff silty clay to clay CLAY |
| | 18.1-18.3 | | Dense sand to sand SAND |
| | 18.3-20.0+ | | Very stiff clayey silt to silty clay SILT/CLAY |

APPENDIX 3
Samples examined, described and/or subsampled)

Trial Pit 1

| context | Unit samples | | Action |
|----------------|---------------------|---|---|
| 101 | 1 | 1 | Described and subsampled for rapid palaeo-environmental appraisal |
| 102 | 2 | 2 | Described and subsampled for rapid palaeo-environmental appraisal |
| 103 | 3 | 3 | Described and subsampled for rapid palaeo-environmental appraisal |

Trial Pit 2

| context | Unit samples | | Action |
|----------------|---------------------|---|---------------|
| 201 | 0 | 4 | |
| 202 | 2 | 5 | |

Trial Pit 3

| context | Unit samples | | Action |
|----------------|---------------------|---|---------------|
| 301 | 1 | 6 | |
| 302 | 2 | 7 | |
| 303 | 3 | 8 | |

Trial Pit 4

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 401 | 1 | 9 | |
| 402 | 2 | 10 | |

Trial Pit 5

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 501 | 1 | 11 | |
| 502 | 2 | 12 | |

Trial Pit 6

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 601 | 1 | 13 | Described |
| 602 | 2 | 14 | Described |

Trial Pit 7

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 701 | 1 | 15 | Described |
| 702 | 2 | 16 | Described |

Trial Pit 8

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 801 | 1 | 17 | Described |
| 802 | 2 | 18 | Described |

Trial Pit 9

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 901 | 1 | 19 | Described |
| 902 | 2 | 20 | Described |

Trial Pit 10

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 1001 | 1 | 21 | Described |
| 1002 | 2 | 22 | Described |

Trial Pit 11

| context | Unit samples | | Action |
|----------------|---------------------|----|--------------------------|
| 1102 | 0 | 23 | Described - contaminated |

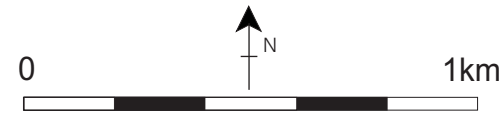
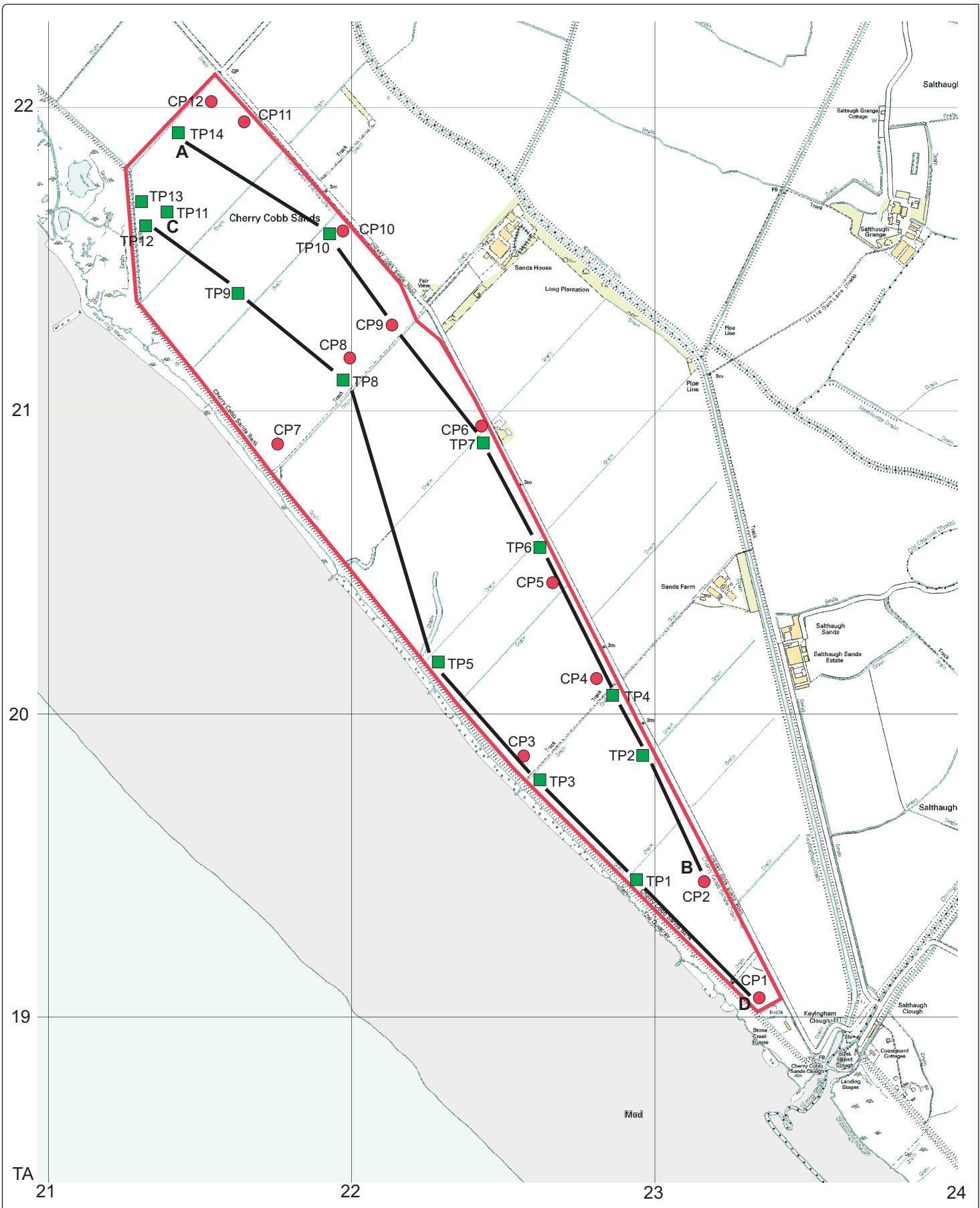
Trial Pit 13

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 1301 | 1 | 24 | Described |
| 1302 | 2 | 25 | Described |

Trial Pit 14

| context | Unit samples | | Action |
|----------------|---------------------|----|---------------|
| 1401 | 1 | 26 | Described |
| 1402 | 4 | 27 | Described |





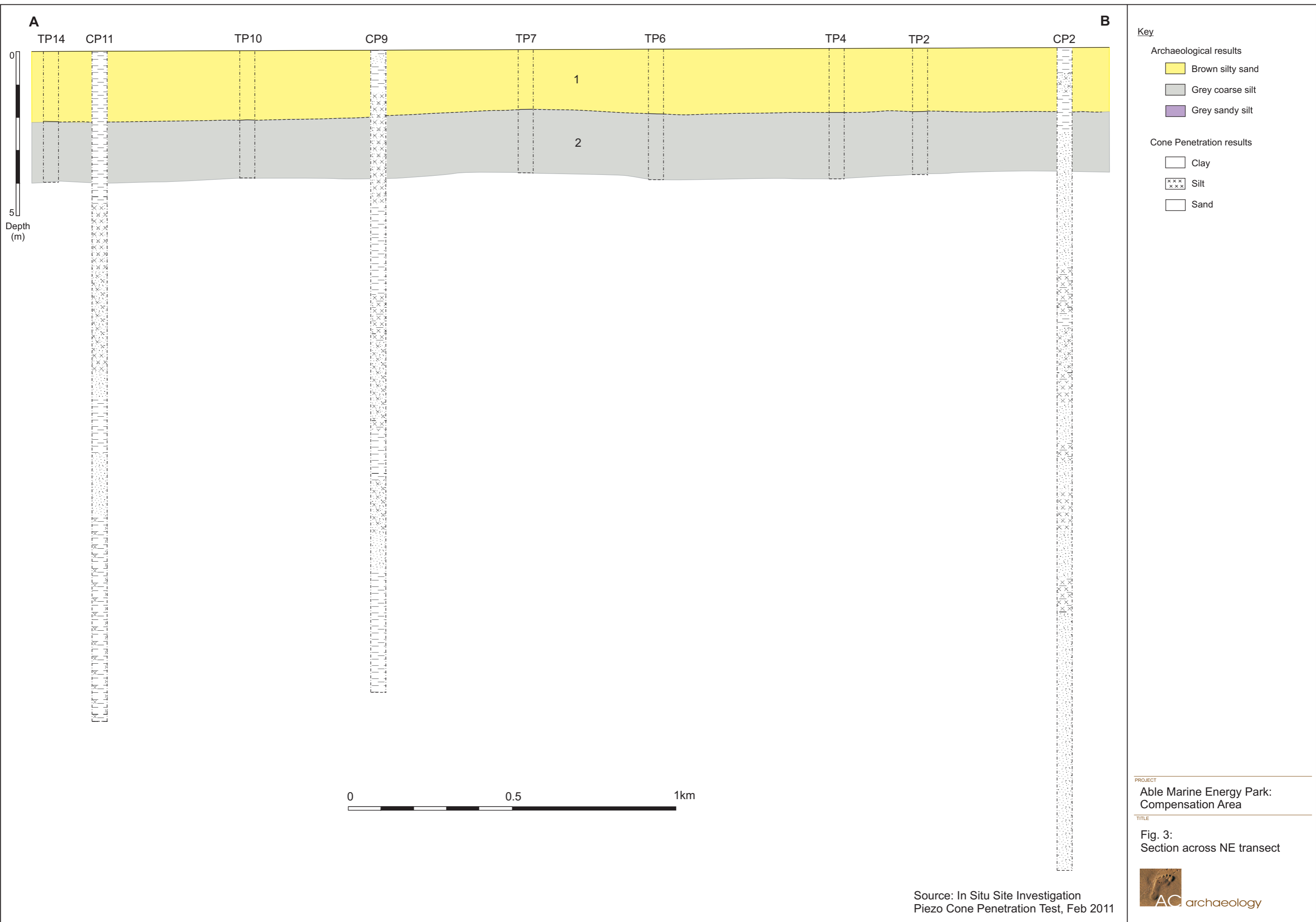
PROJECT

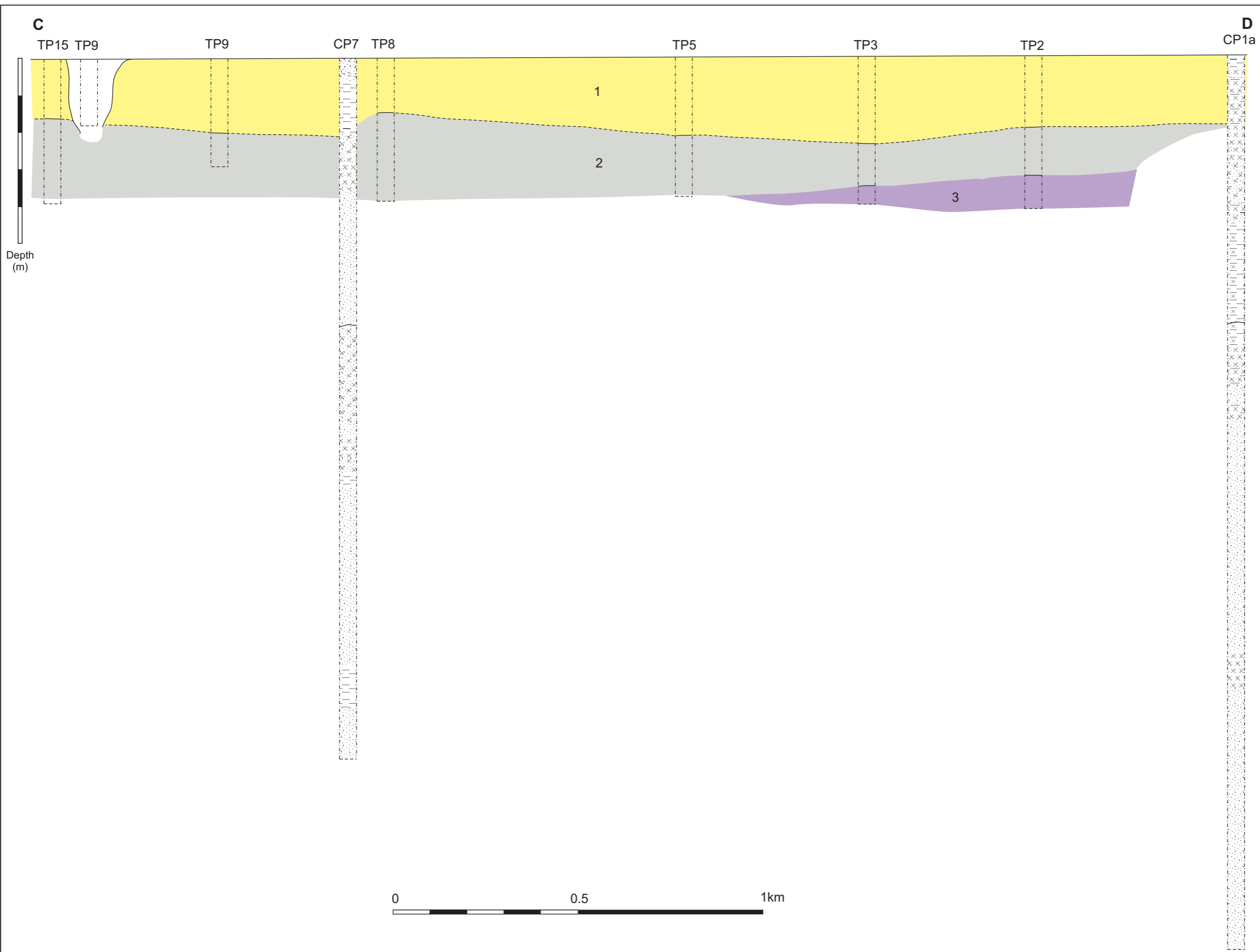
Able Marine Energy Park: Compensation Area

TITLE

Fig. 1: Location of Geotechnical and Cone Penetration excavations

- Key**
- CP5 ● Cone Penetration trial pit
 - TP6 ■ Geotechnical trial pit





- Key**
- Archaeological results**
- Brown silty sand
 - Grey coarse silt
 - Grey sandy silt
- Cone Penetration results**
- Clay
 - Silt
 - Sand

PROJECT
**Able Marine Energy Park:
 Compensation Area**

TITLE
**Fig. 4:
 Section across SW transect**



Source: In Situ Site Investigation
 Piezo Cone Penetration Test, Feb 2011