Lydd Ranges Sea Defence Scheme

Geoarchaeological Borehole Survey

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wessexarchaeology

Portway House
Old Sarum Park
Salisbury
Wiltshire
SP4 6EB

www.wessexarch.co.uk

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Summary
Wessex Archaeology (WA) was commissioned by Mackley Construction to undertake a program of geoarchaeological works in support of the Lydd Ranges Sea Defence Scheme.

In order to offset the impact of coastal defence improvement works on deposits of geoarchaeological interest in the Dungeness, Romney Marsh and Rye Bay SSSI, a programme of geoarchaeological works was required on the foreshore, Green Wall and within marshland landward of the current Green Wall. The works target three areas of marsh (Zones, C, E and G) located between gravel ridges of the Dungeness Foreland.

Work within the marshland landward of the Green Wall involved 30 hand-held window samples, 10 within each zone. This was accompanied by three rotary and sonic cores on the Green Wall to maximum depths of 15m to sample and record the full sequence of Holocene sediments to the surface of the basal sands. Exposures of silty clay were monitored on the foreshore in 14 test pits (scrapes), recording the elevation and retrieving samples where appropriate.

The results of the geoarchaeological works are support by deposit modelling outputs illustrating the key deposits across each zone.

The geoarchaeological works identified a consistent sequence of deposits across Zones C, E and G comprising a basal sand, in turn overlain by sands and gravels, gravels and a sequence of clays and silts with localised organic units. The deposits correspond broadly to the existing preliminary ground model for the scheme, although displaying lateral variation in the presence, composition, thickness and elevation of deposits.

Basal sands, representing shoreface and intertidal deposits were recorded in sonic cores at elevations of -6.26 (Zone C), -6.58 (Zone E) and -6.35 m aOD (Zone G). The deposit will not be impacted by design elements of the scheme and drilling ceased when it was clear this deposit had been encountered.

The overlying sands and gravels are interpreted as evidence for the development of a spit and barrier complex. The total thickness of sands and gravels was recorded in zone E where they reached 2.89 mOD. Poor recovery of this deposit made it difficult to determine the interface between the sands and gravels and overlying gravels.

The overlying gravels represent contemporary storm beach gravels extending up to 6.7m thick. This barrier developed through the longshore movement of offshore derived gravels and form a series of defined ridges and intervening lows. Within the inter-ridge lows, the gravels have an elevation of -0.94 m aOD (Zone C), 1.23 m aOD (Zone E) and -0.15 m aOD (Zone G).

The intervening inter-ridge depressions within the gravel barrier variously contain sequences of fine-grained sediment along with sands, clayey-gravels and localised peats deposited within former tidal inlets. The formation of these marshland sediments reflects a period of significant coastal dynamisms under the influence of the eastward progradation of the gravel barrier, together with rapid sedimentation of the intervening inter-gravel lows.

The fine grained sediment comprised both structureless silty clays overlying laminated silty clays, with surface elevations between 2.05–1.52 m aOD (Zone C), 2.07–1.37 m aOD (Zone E) and 1.90–1.56 m aOD (Zone G). Exposures of silty clay on the foreshore only occur in relation to the corresponding inter-ridge depressions, varying in height from 2.22 m aOD (Zone C), 0.69– -0.85 m aOD (Zone E) and 0.37–0 m aOD (Zone G). A 0.38 m thick peat deposits was recorded in Zone G at -0.72– -0.94 m aOD, located landward of the seawall and stratified in silty-clay marsh deposits.

Recommendations are made for a program of palaeoenvironmental assessment of samples to meet the aims and objectives outlined in the project scope.

Suitable samples for OSL dating to date the above-gravel marsh deposits have been identified in rotary cores, comprises lenses of fine sand preserved in silty clays.

The peat preserved in Zone G landward of the Green Wall has the potential to preserve short-lived plant macrofossils for radiocarbon dating, providing additional scientific dating evidence for the marsh deposits. The geoarchaeological works did not identify any deposits of peat overlying bedrock and there is limited potential for producing data to contribute to for relative sea-level curves.

Xray core scanning is recommended as a rapid, non-destructive and cost effective method for producing high resolution geochemical data for the purposes of investigating the provenance of the above and below-gravel stratigraphy. Careful thought should be given to either extracting samples of cores for OSL dating prior to core scanning or splitting cores and retaining one half for OSL dating and the other half for core scanning.

Following a stakeholder meeting in December 2021, a revised program of assessment and scientific dating was proposed, adopting the original approach but with adjustments made to allow for targeted sampling for scientific dating, with additional microfossil work (diatoms, foraminifera and ostracods) to investigate past environments and land-ocean interactions.

The revised program is divided into two stages. The first stage involves XRF core scanning and palaeoenvironmental assessment, in part to inform on the need for and scope of OSL and radiocarbon dating at Stage 2. The scope of any scientific dating as part of Stage 2 will be discussed at a further stakeholder meeting planned for March 2022.

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Lydd Ranges Sea Defence Scheme

Geoarchaeological Survey

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by Mackley Construction (hereafter referred to as 'the Client') to undertake a program of geoarchaeological works in support of the Lydd Ranges Sea Defence Scheme.

1.1.2 The Lydd Ranges Sea Defence Scheme comprises coastal defence improvement works designed to manage flood and erosion risk along the coastline of Romney Marsh over the next 25 years.

1.1.3 The proposed improvement works extend for approximately 7.4 km west-east from Jury's Gap to Denge Marsh outfall, part of the Romney Marsh and Rye Bay SSSI and including the MOD firing range at Lydd, Kent (**Figure 1**).

1.1.4 The scheme has been divided into a series of Zones (A – K), corresponding to an alternating series of gravel ridges and inter-ridge marshes. The proposed geoarchaeological works are targeted within three of the inter-ridge marshes located at Midrips (Zones C and E) and South Brooks (Zone G).

1.2 Scope of works

1.2.1 In order to offset the impact of coastal defence improvement works on deposits of geoarchaeological interest in the Dungeness, Romney Marsh and Rye Bay SSSI, a programme of geoarchaeological works was required on the foreshore, Green Wall and within marshland landward of the current Green Wall.

1.2.2 The scope of works followed a staged approach, as outlined in Jacobs (2020) and WA (2021a) and revised as works progressed to comprise the following components (**Figure 2**):

- **Inter-ridge marshes:** survey to investigate and map inter-ridge marsh deposits within zones C, E and G, involving a combination of hand augers and hand-held window sampling (HHWS);
- **Green Wall:** Three borehole locations (one each from zones C, E and G) through the Green Wall to sample and record the full sequence of Holocene sediments within the inter-ridge depressions and underlying gravel deposits (but not the basal sand deposits overlying bedrock), achieved through a combination of rotary and sonic drilling methods;
- **Beach works:** Purposive geoarchaeological recording and sampling of clay deposits exposed along the beach fronting zones C, E and G;

1.3 Scope of report

1.3.1 This report details the results of geoarchaeological surveys in the inter-ridge marshes, Green Wall and beach, supporting by targeted deposit modelling.

1.3.2 Samples taken during the above stages of fieldwork were described in the laboratory with recommendations outlined in this report for targeted palaeoenvironmental assessment and scientific dating, where appropriate to the aims and objectives of the work.

1.3.3 The program of works outlined above are designed to address/contribute to a series of principal objectives, developed in consultation with Professor Andrew (detailed in Jacobs 2020, table 4-1). The potential to contribute to these overarching objectives is considered in the discussion (**Section 6**), but comprise the following:

- Investigation the topography of the bedrock and early Holocene depositional environment;
- Developing relative sea-level curves using basal peats overlying bedrock;
- OSL dating of sediments infilling tidal inlets;
- Sediment provenance and land-ocean interaction;
- Origins and archaeology of the Green Wall.

2 GEOARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The following section provides a summary of the known geoarchaeological record for the Site and surrounding landscape. An archaeological background to the Scheme is contained in the accompanying archaeological watching brief WSI (WA 2021b) and is not repeated here.

2.1.2 Where age estimates are available for deposits, these are expressed in millions of years (Mya), thousands of years (Kya) and within the Holocene epoch as years Before Present (BP) with the corresponding Anno Domini (AD) date for historic periods. Where radiocarbon dates are included, the uncalibrated date (BP) is quoted followed by the calibrated date (cal. BP or cal. AD following the above format) date. These dates are supplemented where relevant with the comparable Marine Isotope Stage (MIS) where odd numbers indicate an interglacial period and even numbers a glacial period.

2.1.3 All depths are provided as metres below ground level (mbgl) and metres above ordnance datum (m aOD)

2.2 Bedrock Geology

2.2.1 The underlying bedrock is mapped by the British Geological Survey (BGS) as sandstones, siltstones and mudstones of the Hastings Beds formed 134–145 Mya during the Cretaceous Period.

2.3 Quaternary Geology

2.3.1 The Site is part of the Dungeness Foreland barrier running along the southern shores of Romney Marsh. The sedimentary sequence across the Scheme comprises nearshore sands overlain by gravels of the prograding shingle barrier of the Dungeness Foreland. The barrier is interrupted by a series of natural depressions infilled with fine-grained and locally organic sediment representing tidal inlets and brackish lagoons.

2.3.2 Lydd Ranges has been well studied are part of a significant body of investigation on the Holocene evolution of Romney Marsh and the Dungeness Foreland, including an ALSF (Aggregate Levy Sustainability Fund) study focusing on barrier dynamics and marshland evolution (Long et al 2007).

2.3.3 The results of this research provide an important geomorphological context for the proposed geoarchaeological works, drawing on a geoarchaeological desk-based review and study of the palaeoenvironmental potential of the Lydd Ranges (WA 2018). The current shingle barrier of the Dungeness Foreland overlies a series of older beach ridges that formed part of a more extensive coastal barrier extending from Farlight Head in the west (19km south-west of Lydd) to Hythe in the east (18km north-east of Lydd).

Pre-barrier development

2.3.4 The gravel barrier of the Dungeness Foreland is underlain by a sequence of nearshore sands that are >10 m thick at Jury's Gap and with a surface elevation of around -2 m aOD (Long et al 2006). OSL (Optically Stimulated Luminescence) dating of these nearshore sands demonstrates that they are of a progressively more recent date from west to east as the barrier developed under the influence of eastward longshore drift. The formation of these nearshore sands has been dated in the west at Broomhill to about 5000 years ago and at the eastern end of the scheme to 500 years ago, with an increase in the eastward rate of progradation during the last 2000 years (Long et al 2007, Roberts and Plater 2007).

Gravel barrier development

2.3.5 Development of the shingle gravel barrier of the Dungeness Foreland occurred through the longshore movement of offshore derived gravels and erosion of the Cretaceous chalk cliffs and associated Pleistocene deposits (Long and Hughes 1995), with OLS dates establishing the early formation of the barrier to approximately 5000 BP (Long et al 2007).

2.3.6 Early Holocene sea-level rise also resulted in the drowning, breakdown and retreat of the former barrier systems, with the sediment recycled into the subsequent barrier systems including the Dungeness Foreland (Mellett et al 2012).

2.3.7 The gravel barrier currently has a surface relief of +3 to +4 m aOD between Jury's Gap and South Brooks, with a depth of gravels of up to 6+ m. The gravel barrier gradually prograded eastward, creating a huge tidal lagoon to landward and leading to the establishment of tidal mudflats and saltmarsh across Romney Marsh; these were subsequently replaced by freshwater peats which had begun to form within the adjacent river valleys from 6800 cal. BP.

2.3.8 Marine influence gradually increased from 3000 cal. BP with the development of large tidal inlets at Rye, Romney and Hyde, with freshwater peats succeeded by marine-dominated tidal flats and saltmarsh across Romney Marsh, punctuated by localised survival of raised mire (e.g., Walland Mire) into the medieval period.

Inter-ridge depressions

2.3.9 The last two-thousand years are marked by a close interaction between the barrier development and back barrier environment within Romney Marsh. The opening of a series of tidal inlets through the barrier led to phases of increased flooding and sediment supply into the marsh, followed by subsequent narrowing and closure of these inlets.

2.3.10 These former inlets through the barrier are apparent today as a series of inter-ridge depressions. The connection between these depressions (gravel lows) and the sea is still open to debate. Palaeoenvironmental assessment and deposit modelling will assist in establishing whether marshes were located behind to gravel foreland, were open to the east, or were infilling inter-ridge lows open directly to the tidal ingress from the south.

2.3.11 The chronology of these post-gravel deposits is unclear due to a lack of radiocarbon dating, although palaeomagnetic dating (Plater et al 2006) suggests that these deposits accumulated between 1050-550 BP (AD 900–1400). Recent GI works at the Midrips did identify a 1.1 m thick organic silt (Opus 2014) that has the potential to produce suitable material for radiocarbon dating.

2.3.12 The deposits encountered at the South Brooks are likely to be later than those to the west, reflecting the rapid eastward progradation of the gravel barrier from 2000 years ago. Palaeomagnetic dating of deposits from South Brooks suggests sediment deposition around 925–575 BP (AD1025–1375), with foraminiferal analysis showing a sequence of tidal and brackish environments (Plater et al 2006).

2.4 Geoarchaeological potential

2.4.1 Previous investigations demonstrate the dynamic nature of the Dungeness Foreland and the potential of the deposits within the Scheme, summarised below:

2.4.2 **Gravel barrier:** in the vicinity of Jury's Gap and Midrips the gravel barrier developed from around 4500 years ago, overlying nearshore sands. Although the gravels themselves are radioactively inert and not suitable for OSL dating, underlying nearshore sand deposits have been OSL dated with the potential for understanding subsequent barrier development.

2.4.3 **Inter-ridge depressions:** a series of inlets formed through the gravel barrier and are infilled with basal laminated sandy to sand silty clays overlain by clay silts and locally organic silts, representing tidal through to brackish lagoonal environments. The depth of deposits is likely to be up to 4 m at the Midrips and in the region of 2–4 m at South Brooks and dating from the early and late medieval periods respectively.

2.4.4 There are indications in recent GI (Opus 2014) from South Brooks for preservation of localised organic deposits. The inter-ridge deposits have the most palaeoenvironmental potential for understanding barrier dynamics and coastal evolution, and for recovering palaeoenvironmental remains (pollen, microfauna, plant macrofossils) informing on past vegetation, environment and evidence for human activity and land-use.

3 AIMS AND OBJECTVIES

3.1 Overarching aims and objectives

3.1.1 The overarching aims and objectives of the works include:

- Refine understanding of the presence, nature and distribution of fine-grained minerogenic and organic sediments (in particular the presence of peat deposits of high geoarchaeological potential) infilling inter-ridge depressions at the Midrips and South Brooks marshes;
- To refine understanding of the depth, thickness and extent of foreshore clay deposits during beach works;
- Obtain representative samples through the deposits;
- Assess the geoarchaeological and archaeological significance of the deposits;
- Make suitable and proportionate recommendations for further work where appropriate

3.2 Specific aims and objectives

3.2.1 The specific aims and objectives of the works include:

- Undertake geoarchaeological works, including hand auger/HHWS of marsh deposits across Zones C, E (Midrips) and G (South Brooks) and monitoring of beach works;
- Identify the presence of Holocene sediments infilling inter-ridge depressions, in particular the potential for in-situ peat deposits, and foreshore clay deposits with palaeoenvironmental potential
- Record sequences and obtain suitable samples from deposits, including three ~15m boreholes from the Green Wall to characterise the full sequence of deposits (one borehole each for zones C, E and G);
- Correlate available GI data to develop a deposit model for the Site, including where appropriate representative transects, thickness plots and Digital Elevation Models (DEMs);
- Establish the potential of the deposits to preserve palaeoenvironmental remains;
- Report on the results, with recommendations and proposals for further work where appropriate;

4 METHODS

4.1 Introduction

4.1.1 Geoarchaeological works will involve a staged approach to investigation and sampling of deposits across Zones C, E and G (**Figure 2**), comprising comprise the following components:

- **Green Wall boreholes**: three ~15 m deep boreholes located along the top of the Green Wall to sample the full Holocene sequence (except the basal sands directly overlying the bedrock), comprising one borehole location in each of Areas C, E and G utilising rotary and sonic drilling methods

- **Inter-ridge marsh survey**: investigate and map inter-ridge marsh deposits within zones C, E and G, focusing in particular on the above-gravel stratigraphy for sediment provenance work

- **Beach works**, involving monitoring of scrapes to expose and sample intertidal clay deposits. Beach works are required to investigate clay deposits on the foreshore fronting zones C, E and G, documenting the elevation and thickness of the clay deposit and providing additional samples for targeted palaeoenvironmental assessment where appropriate.

4.2 Inter-ridge marsh

Hand auger

4.2.1 An Eijelkamp manual gouge auger with a 50mm diameter and 1m long open barrel was used to investigate soft sediment to a maximum depth of 2m at 50 locations across Zone C (16) Zone E (17) and Zone G (17). The auger was pushed down manually through the deposits using a T-bar handle. One metre extension rods were added, where possible, to extend the depth to 2 mbgl (metres below ground level).

Hand Held Window Sampling

4.2.2 Ground and weather conditions presented serious challenges for the hand auger survey and a follow up surveying in October 2021 using a Hand Held Window Sampler (HHWS) recover sleeved cores 100mm diameter and 1 m in length to a depth of 2 mbgl.

4.2.3 The HHWS survey comprised 30 boreholes, 10 each in Zone C, E and G, to depths of 2 mbgl. Sixteen of the HHWS refused at 1m on coarse-grained clayey gravels, in cases preserved beneath fine-grained marsh sediment. The cores were split and described on-site by the geoarchaeologist as work proceeded with representative sequences resealed and returned to the Wessex Archaeology laboratory at Salisbury for further detailed geoarchaeological investigations.

4.3 Green Wall boreholes

Rotary drilling

4.3.1 A total of three boreholes across Zones C, E and G were drilled through the Green Wall using a rotary drilling rig (Pioneer 3 type) during March 2021.

4.3.2 The boreholes aim to sample and record the full sequence of Holocene sediments within the inter-ridge depressions and underlying gravel deposits but not disturb the basal sand deposits overlying the bedrock.

4.3.3 Cores 1.5 m in length and 100mm diameter were recovered in opaque liners for possible later OSL dating. Each sequence was sealed and marked with the project number, site number, borehole number and sample depth before being returned to the Wessex Archaeology laboratory for later description.

Sonic drilling

4.3.4 Rotary cores in all three zones refused on coarse gravel deposits, requiring a subsequent phase of fieldwork in September 2021 using a Sonic drilling rig. Boreholes were advanced at each location to a maximum depth of 15 m below the surface of the Green Wall or to the surface of the basal sands if encountered at a depth < 15 mbgl.

4.3.5 Samples, either retained in liners or bag samples were recovered from deposits below the depth reached during the rotary drilling; sealed and marked with the project number, site number, borehole number and sample depth and returned to the Wessex Archaeology laboratory for later description.

4.4 Beach works

4.4.1 Beach works are required to investigate clay deposits on the foreshore fronting zones C, E and G, documenting the elevation and thickness of the clay deposit and providing additional samples for targeted palaeoenvironmental assessment where appropriate. Purposive geoarchaeological works will be undertaken in parallel with groyne construction, involving the exposure, recording, and where appropriate, sampling of foreshore clay deposits.

4.4.2 At selected locations beach gravel deposits will be removed to expose the underlying shallow buried clay. It is anticipated that these works will be undertaken where the clay deposits are largely exposed or known to be very near the surface and avoiding the need for deep unstable and inaccessible pits. Sections will be machine excavated under the direction and supervision of the attending geoarchaeologist who will record (written and photographic) and sample the deposits. Contacts between stratigraphic units will be surveyed.

4.4.3 Monolith samples will be retrieved from selected cut-back and cleaned section faces, sealed and marked with the project number, site number, sample number and depth before being returned to the Wessex Archaeology laboratory.

4.4.4 Purposive geoarchaeological interventions will be dug to ensure they are safe to enter, record and sample. No member of staff will enter a trench with unsupported sections deemed unsafe. Interventions will be stepped at a maximum of no more than 1.2m, informed by the cohesivity of the deposits.

4.5 Deposit modelling

4.5.1 Deposit modelling enables the subsurface topography to the mapped accurately, locating deposits of archaeological and geoarchaeological potential in three-dimensions.

4.5.2 All available data points will be entered into industry standard software (Rockworks™ v17.0). Each lithological description (e.g., peat, clay, silt, sand etc.) will be given a colour and pattern allowing cross correlating and grouping of the different sediment and soil types. The grouping of these deposits is based on these lithological descriptions, which define distinct depositional environments referred to as ‘stratigraphical units’ (e.g., alluvium, peat, buried soils etc.).

4.5.3 Where suitable contexts are present, stratigraphical units representing certain depositional environments and/or landforms, will be reconstructed both laterally and horizontally. These can then be used to create lateral transects, thickness plots and DEMs where appropriate to illustrating the deposits.

5 RESULTS

5.1 Introduction

5.1.1 A programme of geoarchaeological works was undertaken in Zones C, E and G along the foreshore, Green Wall and marshland landward of the Green Wall over the course of 2020

and 2021 (**Figure 2**). The scope of works followed a staged approach, detailed in **Section 1.2** and Jacobs (2020) and outlined in **Table 1** below.

5.1.2 The results of the geoarchaeological works are tabulated in **Appendix 1–3** and summarised below, focusing on the deposits encountered and supported by deposit modelling (**Figures 3–6**).

Table 1 Survey works at Lydd Ranges

Area / method		Dates	Zone C	Zone E	Zone G
Marsh	**HHWS**	Sept 2021	121-130	111-120	101-110
	HA	Nov 2020	HA1-HA16	HA17-HA33	HA34-HA43
Green Wall	**RC**	March 2021	C01	E01	G01
	SC	Aug 2021	WA-SC03	WA-SC02	WA-SC01
Beach	**TP**	July 2021	1	2, 3, 13, 14	4 – 12

HHWS = hand held window sample; HA = hand auger; RC = rotary core; SC = sonic core; TP = trial pit

Inter-ridge marsh hand auger survey (Nov 2020)

5.1.3 The works initially comprised plans for a grid of approximately 50 hand auger holes across zones C, E and G in marshland landward of the Green Wall. However, ground and weather conditions presented significant challenges to the work and in no case was the target depth of 2 mbgl reached. The marsh surface was flooded, preventing UXO (unexploded ordnance) clearance. Hand auger locations were restricted to transects along the base of the Green Wall, comprising the following auger holes in Zone C (HA1–HA16), Zone E (HA17–HA33) and Zone G (HA34–HA43). Most auger holes were not advanced beyond ~0.3-0.5 m due to the increasingly stiff silts and clays with no location extending beyond 1.0 mbgl. The decision was taken to wait till summer of 2021 when the marshes would hopefully be dry out before undertaking a second phase of work to investigate the marsh deposits using a hand-held window sampling kit.

Green Wall rotary coring (March 2021)

5.1.4 Three rotary cores were drilled on the Green Wall, one in each of Zones C, E and G, with the aim of investigating the full sequence of Holocene sediments to the basal sands at anticipated depths up to 15 mbgl. However, in all three cases the rotary cores refused on gravel deposits at depths of 9 mbgl (C01, Zone C), 6 mbgl (E01, Zone E) and 10.5 mbgl (G01, Zone G) respectively, requiring a subsequent phase of fieldwork using a Sonic drill.

Beach survey (July 2021)

5.1.5 Monitoring of beach works was undertaken during July 2021 in parallel with the construction of groynes, involving machine excavated scrapes to expose lay deposits sealed below beach gravels. In total 14 scrapes were monitored across Zones C (TP1), E (TP2, 3, 13-14) and G (TP4-12) with elevations taken on the surface of the clay deposits. Although the scrapes were stepped, the degree of water ingress made them unsafe to enter and only one monolith sample was recovered through the clays in TP 11 (Zone G).

Green Wall sonic coring (August 2021)

5.1.6 An additional phase of coring on the Green Wall using a Sonic drill was undertaken during August 2021 with the aim to record and sample the remaining sequences following on from the depths reached at each of the rotary core locations. Each sonic core successfully penetrated the gravels with samples retained from the underlying stratigraphy to depths of 13.5 mbgl (Zones C, WA-S03) and 15 mbgl (Zones E, WA-S02 and G, WA-S01).

5.1.7 The combined rotary/sonic logs are referred to as C01/WA-S03 (Zone C), E01/WA-S02 (Zone E) and G01/WA-S01 (Zone G).

Inter-ridge marsh hand held window sampling (September 2021)

5.1.8 The final phase of fieldwork was undertaken in September 2021, involving 30 hand-held window samples (HHWS), ten in each Zone along three transects (Zone C, HHWS 121 to HHWS 130; Zone E, HHWS 111 to HHWS120; Zone G, HHWS101 to HHWS110. Four cores were retained (HHWS104, 107, 114 and 125) one each containing alluvium and a fourth comprising peat from Zone G (HHWS107).

5.2 Stratigraphy

5.2.1 The lithological units identified during the course of the geoarchaeological works are summarised below, supported by the deposit modelling. Not all deposits were present in each zone. A tabulated summary of the deposits across the site and their elevations is provided in **Table 2**.

- Topsoil
- Shingle
- Silty clays (marsh deposits)
- Peat
- Organic silts and clays (foreshore clay deposits)
- Gravels
- Sands and gravels
- Sands

Deposit modelling

5.2.2 Deposit models were generated for each zone comprising west-east oriented lateral transects through the marsh deposits, with additional north-south oriented transects illustrating the key deposits and variation in elevation of clay deposits across the site (**Figures 3–5**). A further transect was produced combining the west-east transects across Zones C, E and G (**Figure 6**).

5.3 Inter-ridge marsh

5.3.1 The inter-ridge boreholes (HHWS 101 to 130) display a variable sequence across the Zones C, E and G, including the following key deposits.

- Topsoil;
- Fine grained silty clays (marsh deposits);
- Peat;
- Coarse-grained predominantly clayey gravels and flint gravels underlying fine-grained marsh deposits,

- Coarse-grained clayey gravels to 1 mbgl with drilling typically refusing at this depth,
- Coarse grained clays over and underlying fine-grained marsh deposits

5.3.2 Hand-Held Window Samples had a maximum depth of 2 mbgl, but in sixteen cases (9 in Zone C and 7 in Zone E) refused at 1m depth, in all cases on coarse-grained clayey gravels; the context of these gravels are discussed below.

Topsoil

5.3.3 Topsoil was recorded in 13 of the 30 HHWS, including 3 cores from Zone E (HHWS111, 113 and 114) and 10 from Zone G (HHWS101-110), comprising a dark brown silty clay and varying in thickness from 0.06–0.3 m.

Near surface gravel deposits (0–1 mblg)

5.3.4 Gravel rich deposits were encountered at or near the surface below topsoil in eleven HHWS, 1 from Zone G (HHWS 101), 7 from Zone E (HHWS 112, 113, 116–120) and 3 from Zone C (HHWS 121, 124 and 126) (**Figures 3–5**).

5.3.5 The deposits typically comprise clayey gravels to a depth of 1.0 mblg before refusal, with no evidence for overlying fine-grained marsh deposits.

5.3.6 In 9 of the 11 cores there was no indication of the depth of gravelly clay deposits or indication of the underlying stratigraphy. However, 0.4 m of gravelly clays were recorded overlying fine-grained marsh deposits in HHWS 113 (0.1–0.5 mblg; 1.77–1.37 mblgl) and HHWS 126 (0–0.4 mblgl 2.25–1.85 mOD).

Gravel deposits underlying fine-grained marsh deposits

5.3.7 Gravel rich deposits, typically clayey gravels and flint gravels in a silty-clay matrix, were recorded underlying fine-grained marsh deposits in 8 cores, 5 from Zone C (HHWS 122, 123, 125, 129 and 130), 2 from Zone E (HHWS 111 and 113) and 1 from Zone G (HHWS102) (**Figures 3–5**).

5.3.8 The elevation of these gravels-rich deposits, where cropping out below the fine-grained marsh deposits, varied between 0.79–1.43 m aOD (Zone C), 0.3– -0.05 m aOD (Zone E) and 0.76 m aOD (Zone G).

Silts and clays (Fine-grained marsh deposits)

5.3.9 Fine-grained silts and clays were recorded in 20 hand-held window samples, including eight in Zone C (HHWS122, 123, 125-130), three from Zone E (HHWS113-114) and nine from Zone G (HHWS102-110).

5.3.10 Evidence for two distinct silty clay units was recorded in cores across Zones C, E and G; an upper unit comprising a firm silty clay with evidence for iron mottling, in several cases overlying a stiff grey silty clay with evidence for laminations.

5.3.11 In Zone C the structureless silty clay was recorded in all eight cores, with evidence for a laminations in only one core (HHWS127). Silty clays overly gravel-rich deposits in five cores (HHWS122, 123, 125, 129 and 130), with a thickness of 0.13–1 m, outcropping between 0–0.4 mbgl and with a surface elevation varying between 2.07mOD (HHWS125) and 1.52 m aOD (HHWS130).

5.3.12 In Zone E silty clays were recorded in three cores (HHWS111, 113 and 114) comprising a single unit of stiff silty clays with evidence for laminations overlying gravels in HHWS111 (0.06–1.7 mbgl; 1.94–0.3 m aOD) and HHWS113 (0.5–1.95 mbgl; 1.37– -0.05 m aOD), with HHWS214 comprising an iron mottled silty clay (0.2–0.6 mbgl; 2.07–1.67 m aOD) overlying a weakly laminated silty clay (0.6+ mbgl)

5.3.13 Nine cores from Zone G preserved silty clays, all include the upper iron mottled silty clay overlying a silty clay with evidence for laminations. Compression voids (a result of the percussion coring process) were recorded in silty clays in several cores, and in only one cores (HHWS102) was the total depth of silty clays overlying gravels recorded totalling 0.9 m (0.1–1.0 mbgl; 1.66–0.76 m aOD). The surface elevation of the silty clays varied between 1.9 m aOD (HHWS107) and 1.56 m aOD (HHWS103).

Peat

5.3.14 Peat was recorded in only one borehole (HHWS107) from Zone G landward of the Green Wall (**Figure 5**). The 0.38 m thick silty clay peat is stratified in fine grained marsh deposits at a depth of 0.59–0.97 mbgl (1.41–1.03 m aOD) with both clear upper and lower boundaries.

5.4 Green Wall

Made ground/sea wall

5.4.1 Concrete over clayey gravel was recorded in rotary core C01/WA-S03 (Zone C), including 0.2 m of concrete overlying a clayey gravel with large fragments of concrete to 1.2 mbgl. Underlying deposits of orange-brown fine-grained silty clays recorded in rotary cores are likely to represent redeposited material used in the construction of the Green Wall, occurring above the elevations for fine-grained marsh deposits recorded in hand-held window samples landward of the Green Wall.

Organic silts

5.4.2 Lenses and bands of organic silt bands were recorded stratified in fine grained deposits in rotary cores E01/WA-S02 (Zone E) 3.10–3.20 mbgl (3.28–3.18 m aOD) and G01/WA-S01 (Zone G) at 3.70–3.86 mbgl (2.8–2.86 m aOD). These units occur well above the elevation of marsh deposits investigated landward of the sea wall (see Section 5.3 below) are likely connected to the history of the sea wall (**Figures 3–6**).

Clays and silty clays

5.4.3 Fine grained deposits were recorded in all three rotary cores advanced through the Green Wall. Some of these fine-grained deposits are likely to have been redeposited as part of the construction material for the overlying sea wall.

5.4.4 Borehole C01/WA-SO3 (Zone C, **Figure 3**) comprised a sequence of fine-grained deposits extending from 1.2–7.4 mbgl (5.26– -0.94 m aOD) including a mid-grey silty clay (3.4–7.18 mbgl, 3.06– -0.72 m aOD) overlying a blue grey silty sand sealing gravels. Occasional rounded flint and chert pebbles are recorded in the upper unit (1.2–3.4 mbgl), comprising an orange-brown to mid-grey silt clay.

5.4.5 Borehole E01/WA-S02 (Zone E, **Figure 4**) comprised a sequence of fine-grained deposits extending from 1.3–5.3 mbgl, including a redeposited yellowish-brown silty clay with frequent ceramic building material and grit (1.3–1.85 mbgl; 5.23–4.68 m aOD), overlain by a light orange-brown silty clay (1.85-3.40 mbgl; 4.68–3.13 m aOD) with occasional rounded gravels, fragments of eroded and redeposited peat and organic clay band. A light

greenish grey silty clay was recorded overlying gravels from 3.40–5.30 mbgl (3.13–1.23 m aOD), including occasional sub-rounded flint gravels.

5.4.6 Borehole G01/WA-S01 (Zone G, **Figure 5**) comprised a sequence of fine-grained sediment extending from 1.57–6.65mbgl (4.93– -0.15 m aOD), including a structureless mid grey silty clay with frequent coarse sand (grit) and gravels (1.57–2.00 mbgl; 4.93–4.50 m aOD).There was no recovery between 2 and 3mbgl.

5.4.7 Orange-brown silt clay with occasional flint gravels was recorded from 3–3.97 mbgl (3.50–2.53 m aOD), including fragments of peat and bands of organic silty clay (3.7–3.86 mbgl). This unit was underlain by a greyish brown silty clay (3.97–5.78 mbgl; 2.53–0.72 m aOD), in turn overlying a greyish brown fine sand (5.78–6.00 mbgl; 0.72–0.50 m aOD) and greyish brown silty clay (6.00 to 6.65mbgl; +0.50 to -0.15mOD), including bands of mineralised organics and rare shell fragments.

Gravels

5.4.8 Gravels were recorded in the three rotary and sonic boreholes advanced through the Green Wall (**Figure 6**), comprising clast supported subrounded to rounded flint gravels and cobbles. The surface of the gravels was encountered at 7.4 mbgl (-0.94 m aOD; Zone C), 5.3 mbgl (1.23 m aOD; Zone E) and 6.65 mbgl (-0.15 m aOD; Zone G). The total recorded thickness of gravels in Zone C was 1.6 m (7.4–9 mbgl; -0.94– -2.54 m aOD); there was no recovery between 9–12 mbgl. In Zone D the gravels were 5.2 m thick (5.30–10.5 mbgl; 1.23– -3.97 m aOD) resting directing on sands and gravels. In Zone G the gravels were 3.85m thick (6.65 – 10.5 mbgl; -0.15 – -4.0 m aOD) with no recovery from 10.5 to 12.11 mbgl.

Sands and gravels

5.4.9 Sands and gravels were recorded in the sonic boreholes advanced through the Green Wall, overlying basal sands and overlain by storm beach gravels. The sands and gravels comprise firm grey medium to coarse sands with sub-angular to sub-rounded gravels.

5.4.10 No recovery between 9-12 mbgl in core C01/WA-S03 (Zone C) and between 10-5–12.11 mbgl in core G01/WA-S01 (Zone G) suggest the full thickness of sands and gravels is likely greater at these locations, with a recorded thickness of 1.72 m (Zone C, 12–12.72 mbgl; -5.54– -6.26 m aOD) and 0.74 m (Zone G, 12.11–12.85 mbgl; -5.61– -6.35 m aOD) respectively. The full thickness of sands and gravels was established in E01/WA-S02 (Zone E) at 2.89 m (10.5–13.11 mbgl; -3.97– -6.58 m aOD), directly overlain by storm beach gravels.

Sands

5.4.11 Sonic cores encountered sands sealed beneath sands and gravels at 12.72 mbgl (-6.26 m aOD, Zone C), 13.11 mbgl (-6.58 m aOD, Zone E) and 12.11 mbgl (-6.35 m aOD, Zone G). The deposits variously comprise fine to medium-coarse poorly sands, with bands of silty clay in CO1/WA-S03 (13.03–13.27 mbgl; -6.57– -6.81 m aOD) and E01/WA-S02 (14.33–14.43; -7.80– -7.90 m aOD).

5.4.12 The full thickness of sands was not established as the deposits will not be impacted by design elements of the scheme. Drilling ceased as soon as it was established boreholes had penetrated the basal sands.

5.5 Beach works

Beach shingle

5.5.1 Beach shingle was recorded in all 14 beach scrapes (TPs 1–14), varying between 0.6 to 0.8 m thick and comprising small to large rounded to sub-rounded pebbles and stones and moderate to large rounded and sub-rounded cobbles. The beach shingle outcrops on the surface of the foreshore at elevations between 2.22 m aOD (Zone C), 0.37– -0.82 m aOD (Zone E) and 0.69– -0.85 m aOD (Zone G) (**Figures 3–5**).

Organic silts

5.5.2 Firm black organic silts were recorded in all 14 beach scrapes, sealed beneath 0.6 to 0.8 m of beach shingle. The surface of the organic silts varied in elevation between 1.02 m aOD in Zone C (TP1), -0.33– -1.12 m aOD in Zone E (TPs 2, 3, 13 and 14) and -0.11– -1.45 m aOD across Zone G (TPs 4-12). The thickness of the organic silts was not determined due to the 1.2 m maximum depth of scrapes. One monolith sample was recovered through the organic silts in TP 11.

6 DISCUSSION

6.1 Introduction

6.1.1 A programme of geoarchaeological investigations was undertaken across the scheme in order to offset the impact of coastal defence improvement works on deposits of geoarchaeological significance, focusing on multiple locations on the foreshore, Green Wall and marshes landward of the Green Wall. These investigations were focused within three Zones (C, E and G) located between gravel ridges of the Dungeness Foreland (**Figure 2, Table 1**).

6.1.2 A total of 30 hand-held window samples were undertaken to a maximum depth of 2 mbgl in the marshes landward of the Green Wall, 10 within each of Zones C, E and G. Three rotary and sonic cores were undertaken along the top of the Green Wall to investigate and recover the Holocene deposits to the surface of the basal sands at a maximum depth of ~15 mblg. In addition, 14 machine excavated scrapes were monitored on the beach to record the elevation of clay deposits sealed beneath beach shingle (**Table 1**).

6.1.3 Geoarchaeological investigations were supported by deposit modelling (**Figures 3–6**), helping to refine understanding of the presence, nature and distribution of superficial geological deposits across the site. The results are considered below in the context of existing understanding of the geomorphology and depositional environment of the Dungeness Foreland, and with reference to the aims and objectives of the works as outlined in the WSI (WA 2021a) and Jacobs (2020).

6.2 Geomorphology and depositional environments

6.2.1 The scheme is situated within the Dungeness Foreland barrier system which extends along the southern shores of Romney Marsh and the English Channel. There has been extensive investigation of the geological and geomorphological history and development of this landscape, with significant lateral variation in the sedimentary architecture evidence across the Foreland, reflecting the interplay of sea-level rise, coastal processes and human activity over the Holocene period.

6.2.2 The geoarchaeological works identified a consistent sequence of deposits across Zones C, E and G comprising basal sands in turn overlain by sands and gravels, gravels and a

sequence of clays and silts with localised organic units (**Figure 6**). The full sequence was only investigated through rotary and sonic cores through the Green Wall. The sequence of clays and silts was investigated in the marshes landward of the Green Wall and on the foreshore where exposures of silty clay were recorded below deposits of shingle.

6.2.3 The deposits recorded during the geoarchaeological works correspond broadly to existing preliminary ground models for the scheme (Jacobs 2020). The sequence of deposits, although displaying lateral variation in the presence, composition, thickness and elevation of deposits (**Table 2**), is broadly consistent across the three zones, comprising the following:

- Nearshore marine sands;
- Shoreface intertidal sands and gravels, forming successive ridges and lows;
- Storm beach gravels, forming the Dungeness Foreland barrier system with ridges and intervening lows (inter-ridge depressions);
- Fine-grained intertidal marsh sediments infilling the inter-ridge depressions, also including deposits of sand, gravels and localised peat/organic sediment, and;
- Sea defence (Green Wall) comprising redeposited silt and clay with some evidence for internal structure

6.2.4 The basal deposits recorded in the sonic cores comprise a sequence of sands, including lenses of silty clay, representing prograding shoreface and intertidal deposits laid down over the last c. 5,000 years (Roberts and Plater 2007).

6.2.5 The sequence of nearshore sands are up to 10m thick at Jury's Gap which forms the topographic basement on which the subsequent barrier developed. They are of a progressively more recent date from west to east, under the influence of nearshore drift, and have been OSL dated between Jury's Gap and the Wicks to between approximately 4650±200 BP to 3580±180 BP (Long et al 2007, Roberts and Plater 2007).

6.2.6 The nearshore sands are not impacted by design elements of the scheme and drilling was halted when it was clear boreholes had penetrated into this deposit; no samples of this deposit were retained.

6.2.7 Overlying the sands are deposits of sands and gravels which are interpreted as evidence for development of a spit and barrier complex initiated by high rates of alongshore sedimentation. The total thickness of this deposits was only determined in Zone E where sands and gravels reached 2.89 m, resting on the underlying sands at -3.97 m aOD (Figure 6).

6.2.8 The sands and gravels are in turn overlain by contemporary storm beach gravels. Deposits of flint gravels and cobbles between 4.6 and 6.7 m thick were recorded in rotary and sonic cores along the Green Wall, representing the gravel barrier of the Dungeness Foreland. This shingle barrier developed through the longshore movement of offshore derived gravels recycled through the erosion and retreat of earlier offshore barrier systems and through erosion of the Cretaceous chalk and Wealden Group cliffs (Long et al 1995; Mellett et al 2012).

Table 2 Summary of Holocene stratigraphy and range in the upper/lower elevation of key units across the scheme

	Zone C			Zone E			Zone G		
Deposit	**Deposit thickness (m)**	**Surface m aOD**	**Base m aOD**	**Deposit thickness (m)**	**Surface m aOD**	**Base m aOD**	**Deposit thickness (m)**	**Surface m aOD**	**Base m aOD**
Marsh									
Topsoil	0.1 – 0.3	1.73 – 2.0	1.52-1.9	0.06 – 0.2	2.27 – 1.87	1.77 – 2.07	-	-	-
Gravels (only deposit)	1.0+	1.72 – 1.68	-	1.0+	1.9 – 1.52	-	1.7+	1.52	-
Gravels (over silty clays)	0.4	2.25	1.85	0.4	1.77	1.37	-	-	-
Silty clays	0.55 – 1.9+	2.05 – 1.52	1.43 – -0.34	1.45 – 1.8+	2.07 – 1.37	-0.05	0.13 – 1.8+	1.9 – 1.56	1.28 – -0.26
Peat	-	-	-	-	-	-	0.38	1.41	1.03
Gravels (below silty clays)	1.0+	1.43 – 0.79	-	0.4+	0.3 – -0.05	-	1.0+	0.76	-
Green Wall									
Sea wall	-	6.46	-	-	6.54	-	-	6.50	-
Silty clays*	6.2	5.26	-0.94	5.0	5.23	1.23	5.06	4.93	-0.15
Gravels	1.6+	-0.94	-	5.2	1.23	-3.97	3.85+	-0.15	-
Sands and Gravels	1.72+	-	-6.26	2.89	-3.97	-6.58	0.74+	-	-6.35
Nearshore sands	-	-6.26	-	-	-6.58	-	-	-6.35	-
Beach									
Shingle	0.8	2.22	1.02	0.3 – 0.7	0.37 – -0.78	-0.33 – -1.12	0.3 – 0.8	0.69 – -0.85	-0.11 – -1.45
Organic clays	-	1.02	-	-	-0.33 – -1.12		-	-0.11 – -1.45	-

* including redeposited silty clays used in construction of sea wall. Boundary between deposited and in-site clays not clear in boreholes.

6.2.9 The gravel barrier forms a series of defined ridges and intervening depressions, the latter represented by Zones C, E and G. The gravel barrier has a current maximum surface elevation of between +3 to +4 m aOD, with elevations of -0.94 m aOD (Zone C), 1.23 m aOD (Zone E) and -0.15 m aOD (Zone G) recorded within the intervening inter-ridge depressions (**Figure 6, Table 1**).

6.2.10 The movement of this barrier from west to east resulted in the creation of a huge tidal lagoon to landward with the development of mudflats, saltmarsh and peat across Romney Marsh. The intervening inter-ridge depressions within the gravel barrier variously contain sequences of fine-grained sediment along with sands, clayey-gravels and localised peats deposited within former tidal inlets. The formation of these marshland sediments reflects a period of significant coastal dynamisms under the influence of the eastward progradation of the gravel barrier, together with rapid sedimentation of the intervening inter-gravel lows.

6.2.11 The fine grained sediment comprised both structureless silty clays overlying laminated silty clays. Marsh deposits infilling these inter-ridge depressions have been interpreted as blind channels, open to the sea but largely protected from wave action with sediment deposited primary under tidal influence (Plater et al 2009), preserved in the form of

laminations reflecting tidal cycles. Plater et al (2009) similarly record an upward transition in marsh deposits from laminated to structureless muds, locally preserving sandy lenses.

6.2.12 The surface of the marsh deposits landward of the Green Wall varied between 2.05–1.52 m aOD (Zone C), 2.07–1.37 m aOD (Zone E) and 1.90–1.56 m aOD (Zone G). Hand-held window samples landward of the Green Wall also consistently record deposits of clayey gravels and flint gravels. Gravels were recorded at relatively shallow depth in 11 cores, 7 from Zone E, 3 from Zone C and 1 from Zone G, typically to depths of 1mbgl where drilling refused. It was not possible in most cases to determine how deep the upper gravel unit extends or whether they seal marsh deposits. However, in 2 cores (HHWS 113 and 126), 0.4m of gravelly clay was recorded sealing fine-grained marsh deposits.

6.2.13 In most, although not all cases, the gravel deposits recorded from c. 0–1mbgl occur along or near the edges of the inter-ridge zones or towards the base of the Green Wall. It seems probable therefore that these shallow gravel deposits may represent more recent periodic erosion (e.g., during storms and barrier breaches/overtopping) or progradation of the gravel barrier.

6.2.14 In a further 8 cores, gravel deposits were recorded underlying the fine-grained marsh sediment. The majority of gravels underlying the marsh deposits were recorded from Zone C, largely a consequence in this area of the absence of shallow gravel deposits which in Zones E and G often resulting in drilling refusing at 1 mbgl.

6.2.15 The gravels were recorded at depths of between 0.33 (HHWS 223) and 1.7 mbgl (HHWS 111) below a variable thickness of fine-grained marsh deposits. The surface elevation of the contact between the gravels and marsh also varied, ranging between 0.79–1.43 m aOD (Zone C), 0.3– -0.05 m aOD (Zone E) and 0.76 m aOD (Zone G). Overall, the variable stratigraphy and depth of gravels, including the presence of shallow gravel deposits, and the 2m depth limit for HHWS cores, preventing wider mapping of the sub-marsh gravel deposits from the marshes landward of the Green Wall

6.2.16 Rotary cores on the Green Wall and hand-held window samples in the marshes to landward recorded sequences of firm structureless silty clays infilling these ridges in the gravel topography. Silts and clays in the rotary cores were clearly utilised in the construction of the sea defences and the interface between these and any underlying marsh deposits is not clearly discernible in the cores.

6.2.17 Corresponding silt and clay deposits were also recorded on the foreshore, varying in elevation beneath beach shingle from 1.02 m aOD (Zone C), 0.69– -0.85 m aOD (Zone E) and 0.37–0m aOD (Zone G). The thickness of the clay deposits was not possible to determine due to the maximum 1.2 m depth of scrapes (**Figures 2–5, Table 1**).

6.2.18 The silty clay deposits only outcrop on the foreshore in relation to the corresponding inter-ridge depressions (**Figure 2**), extending out from the adjacent marshes landward of the Green Wall where they have been subject to variable erosion. Only one foreshore scrape was possible in Zone C. However, silty clays along the foreshore of Zones E and G are as much as c. 0.6–2 m lower in elevation than comparable deposits landward of the Green Wall – this difference cannot be accounted for entirely as a result of erosion but also reflects the variable elevation evident in boreholes across the inter-ridge marshes.

6.2.19 The chronology of the post-gravel marsh deposits in-filling the inter-ridge depressions is suggested on the basis of palaeomagnetic dating which provides a broad medieval origin between c. AD 990 to AD 1400 (See Plater et al 2006, 2009, table 2).

6.2.20 Additional opportunities for scientific dating of marsh deposits are presented by a 0.38 m thick peat (1.41–1.03 m aOD) retained in HHWS107 (Zone G landward of Green Wall) in addition to sandy units retained in rotary cores C01 (-0.72– -0.94 m aOD) and G01 (0.72–0.52 m aOD). However, the clear boundaries between peat and silty clay in HHWS107 suggest the peat may be rafted, i.e., eroded and redeposited.

6.2.21 Peat deposits are widely recorded across Romney Marsh, forming in a back barrier environment but are only locally present within the inter-ridge marshes. Earlier GI works (Opus 2014) identified a 1.2 m thick peat (BH06) preserved in silts and clays at 2.3–1.1 m aOD, located c. 2 km to east of HHWS107 within Zone I (South Brooks).

6.2.22 Previous investigation of organic deposits preserved within gravel lows at Broomhill, located to the west of the site, produced a radiocarbon date of 3410±60 BP (1880–1540 cal. BC) (Tooley and Switsur 1988), with peat forming in the gravel low at Wickmaryholm (c. 3 km east of Zone G) during the last 2000 years and ending between 1000-700 years ago consistent with a period of increased storm activity (Long and Hughes 1995). Palaeomagnetic Secular Variation (PSV) dating of marsh deposits suggests a phase of rapid sediment accumulation within the inter-ridge lows between 1100 – 500 years ago (Plater et al 2009).

6.3 Mitigation objectives

6.3.1 The results of the geoarchaeological investigations are considered in relation to the aims and objectives outlined in Jacobs (2020), WA (2021) and listed in **Section 1.3.3;**

- Investigation the topography of the bedrock and early Holocene depositional environment;
- Developing relative sea-level curves using basal peats overlying bedrock
- OSL dating of sediments infilling tidal inlets
- Sediment provenance and land-ocean interactions
- Origins and archaeology of the Green Wall

Investigation the topography of the bedrock and early Holocene depositional environment;

6.3.2 Sonic cores have provided additional data on the post and pre-gravel surface within Zones C, E and G at elevations of -6.26, -6.58 and -6.35 m aOD respectively. The deposits are not impacted by designed elements of the scheme and no samples were retained.

Developing relative sea-level curves using basal peats overlying bedrock

6.3.3 The current phase of works have not identified any basal peats resting on bedrock which could be radiocarbon dated for the purposes of developing relative sea-level curves. Localised samples of peat stratified in marsh deposits (HHWS107) have been retained and on which radiocarbon dating could be undertaken to determine the age and depositional context of the deposit.

OSL dating of sediments infilling tidal inlets

6.3.4 Two of the rotary cores (C01/WA-S03 and G01/WA-S01) contained fine sand deposits within fine-grained marsh sediment with Zones C and G respectively which are deemed suitable for luminescence dating. OSL dating of these fine sands would provide a direct date for the post-gravel inter-ridge marsh deposits. Radiocarbon dating of peat deposits preserved within HHWS207, located in Zone G landward of the Green Wall would provide additional scientific dating evidence.

Sediment provenance and land-ocean interactions

6.3.5 Geoarchaeological works have recovered samples through the above and sub-gravel stratigraphy which would be suitable for geochemical analysis. However, the high resolution sampling required for established techniques such as XRD and XRF would be expensive and arguably not proportionate to the impact of the scheme. Moreover, we lack the regional geochemical data to set any geochemical results in context.

6.3.6 Alternatively, XRF core scanning could provide a rapid, non-destructive and cost effective method for producing high resolution geochemical data. However, the process of x-ray scanning of cores irradiates the samples, comprising the chronological integrity of the deposits (Davids et al 2010). Consequently, careful decisions need to be made about the balance between luminescence dating and core scanning; either splitting cores and retaining one half for scanning and the other for dating or removing sections for dating prior to scanning.

Origins and archaeology of the Green Wall

6.3.7 Rotary cores through the Green Wall suggest that the sea defences at these locations were constructed utilising redeposited silts and clays, oxidised and iron mottled, locally including inclusions of ceramic building material and grit with occasional fragments of organic matter and gravels recorded. Some internal structure is indicated by organic bands recorded in both E01/WA-S02 (3.10-3.20 mbgl; 3.43–3.33 m aOD) and G01/WA-S01 (3.70–3.86 mbgl; 2.8–2.64 m aOD).

6.3.8 The interface between the Green Wall and underlying silty clays is difficult to identify in rotary cores due to the similarity between redeposited and in-situ silty clays. The organic bands recorded in the rotary cores are located c. 2 m above the elevations of silty clays within the adjacent marshes and may therefore reflect part of the internal structure of the sea wall.

7 CONCLUSION AND RECOMMENDATIONS

7.1 Introductions

7.1.1 Geoarchaeological works at Lydd have involved a staged program of investigations focused on coring in the inter-ridge marshes, Green Wall and monitoring of beach works on the foreshore fronting the Green Wall.

7.1.2 Despite challenging ground conditions these works have been achieved with a large measure of success, helping to refine understanding of the geomorphology and identifying deposits with potential for palaeoenvironmental assessment and scientific dating.

7.2 Samples

7.2.1 The following samples were retained from the inter-ridge marshes, Green Wall and beach across Zones C, E and G.

Inter-ridge marsh

- **HHWS125** (Zone C): Gravelly clay (0 – 1.0 mbgl) overlying shingle (1.0-2.0 mblg)
- **HHWS114** (Zone E): 1.8m of silty clay, including basal unit (0.6–1.2 mbgl) with evidence for laminations
- **HHWS104** (Zone G): silty clay from (0.10–0.5 mbgl), no core recovery (0.5–1.0 mbgl) and basal silty clay (1.0–2.0 mbgl) with evidence for laminations. No core
- **HHWS107** (Zone G): 0–1 mbgl retained, comprising silty clay (0.1-0.59 mbgl), peat (0.59–0.97 mbgl) and silty clay (0.97–1.0 mbgl) with evidence for laminations. No core recovery from 1.0–1.75 mbgl.

Green Wall

- **C01/WA-S03** (Zone C): samples retained from 1.2–9 and 12–13.5 mbgl, comprising silty clays (1.2 – 7.4 mbgl) including localised lenses of sand, gravels (7.4 – 9mbgl), No recovery from 9–12 mbgl.
- **E01/WA-S02** (Zone E): samples retained from 1.2–6.5 and 12–13.5 mbgl, comprising silty clays (1.3–5.3 mbgl), gravels (5.3–6.5 m) sands and gravels (10.5–13.11 mbgl) and sands (13.11–15 mbgl).
- **G01/WA-S01** (Zone G): samples retained from 1.2–10.5 and 12–13.5 mbgl, comprising silty clays (1.2–6.65 mbgl) including localised lenses of sand, gravels (6.65–10.5) sands and gravels (12–12.11 mbgl) and sands (12.11–13.5 mbgl). No recovery between 10.5–12.11 mbgl.

Beach

- **TP 11** (Zone G) monolith retained from 0.8–1.3 mbgl, comprising organic silts.

7.3 Recommendations

7.3.1 The following recommendations are made for a proportionate and targeted program of assessment and scientific dating (**Table 3)** to directly address the mitigation objectives as outlined in Jacobs (2020) and **Section 6.3**:

Table 3 Samples recommended for assessment and scientific dating

Technique	Zone C	Zone E	Zone G	Total
OSL dating *above-gravel marsh deposits*	1 (C01/WA-S03)		1 (G01/WA-S01)	2
Radiocarbon dating *Peat, inter-ridge marsh*	-	-	2-4 (HHWS207)	2-4 *
Pollen *Peat, inter-ridge marsh*	-	-	4 (HHWS207)	4 **
Sediment provenance (core scanning)	5–7.4 mbgl (C01/WA-S03)	10.5–13.11 mbgl (E01/WA-S02)	5–6.65 mbgl (G01/WA-S01) 0.1–0.59 mbgl (HHWS207)	~ 6.5 m

* depending on availability of short-lived terrestrial plant macrofossils; ** dependant on the results of AMS radiocarbon dating

OSL dating of tidal inlets

7.3.2 It is recommended that samples are submitted for OSL dating of the above-gravel marsh deposits, including silty sands in C01/WA-S03 (7.18–7.40 mbgl) and lenses of fine sands stratified in silty clays in G01/WA-S01 (5.78–6.0 mbgl).

Radiocarbon dating

7.3.3 Two radiocarbon dates are recommended to date peat preserved in the inter-ridge marsh of Zone G (HHWS207). Samples of peat should be processed from the top and base of the peat to recover suitable short-lived terrestrial plant macrofossils. Should suitable short-lived material be absent, consideration should be given to submitting sets of paired bulks.

Pollen

7.3.4 Dependent on the results of the radiocarbon dating, consideration should be given to undertaking targeted assessment on samples from the peat present in Zone G (HHWS207), focused on assessing the preservation and concentration of palynomorphs and providing outline data on the local environment.

Sediment provenance (core scanning)

7.3.5 It is recommended that XRF core scanning is undertaken on samples of above- and below-gravel deposits as a rapid, non-destructive and cost effective method for producing high resolution geochemical data.

7.3.6 Core scanning is recommended on samples with associated scientific dates, including the above gravel stratigraphy preserved in cores C01/WA-S03 (Zone C), G01/WA-S01 (Zone G) and HHWS207 (Zone G) and the below gravel stratigraphy (sands and gravels) in E01/WA-S02 (Zone E). Careful thought should be given to either extracting samples of these cores for OSL dating prior to core scanning or splitting cores and retaining one half for OSL dating and the other half for core scanning.

7.3.7 It is suggested that samples of the above-gravel marsh deposits from rotary/sonic cores through the Green Wall are not scanned above the maximum elevation of marsh deposits recorded from the associated inter-ridge deposits, thereby avoiding core scanning of silty clays used in construction of the sea defences.

7.3.8 Additional techniques including the assessment microfauna (diatoms, foraminifera, ostracods) are not considered necessary in view of the potential of Xray core scanning to provide high resolution data for consideration of sediment provenance and land/ocean interactions.

7.4 Updated recommendations following stakeholder engagement

7.4.1 Following a meeting a stakeholder engagement meeting in December 2021, a revised program for assessment and scientific dating was agreed which would follow a staged approach as detailed below and in **Table 4**. This adopted the original approach but with adjustments made to allow for targeted sampling for scientific dating, with additional microfossil work (diatoms, foraminifera and ostracods) to investigate past environments and land-ocean interactions.

- Stage 1 – XRF core scanning, pollen and microfossil assessment
- Stage 2 – OSL and radiocarbon dating

Table 4 Updated recommended for assessment and scientific dating

Technique	Zone C	Zone E	Zone G	Total
Stage 1				
XRF core scanning	(C01/WA-S03) 2–7.4 mbgl	(E01/WA-S02) 2–5.3 mbgl	(G01/WA-S01) 2–6.5 mbgl (HHWS 207) 0.1–0.59 mbgl (TP 11) 0.8-1.30 mbgl	max 16m
Pollen *Peat, inter-ridge marsh*	-	-	4 (HHWS207)	4
Diatoms, Foraminifera and Ostracods *Peat, inter-ridge marsh*	-	-	4 (HHWS 207) 4 (TP 11)	8
Stage 2				
OSL dating *above-gravel marsh deposits*	Decision on need/scope to follow stakeholder meeting (03/22).			3 – 5*
Radiocarbon dating *Peat, inter-ridge marsh*				2-4*

*estimated number of samples depending on outcome of stage 1

Stage 1

7.4.2 The scope of XRF core scanning was increased to focused on scanning of the fine-grained above-gravel stratigraphy in all three rotary cores from the Green Wall, in addition to XRF scanning of fine-grained marsh deposits in HHWS 207 (inter-ridge marsh) and TP11 (foreshore).

7.4.3 In addition to producing high-resolution geochemical data, the results of XRF core scanning from the Green Wall will be used to determine the level of mixing apparent in fine grained sediment, with the aim of distinguishing between sediment redeposited during construction of the sea wall and naturally deposited silty clays. The interface between these deposits is not visually apparent in the deposits. Using XRF core scanning is is considered a cost/time-effective means of refining the scope of any subsequent OSL dating at Stage 2.

7.4.4 The XRF scanning will require an exposed sediment surface. XRF scanning will make the cores unsuitable for OSL dating. Consequently, cores will be split in the dark under yellow light with one half retained for OSL dating. Sections will be stored in opaque plastic d-tubes.

7.4.5 Targeted assessment of microfauna (diatoms, foraminifera and ostracods) will be undertaken on fine-grained marsh deposits above and below peat deposits in HHWS-207 and from clays sampled from the foreshore (TP11). The data will provide an environmental context for these deposits in support of the sediment provenance and land-ocean interaction research objective.

7.4.6 Pollen assessment of peat in HHWS 207 will produce data on the concentration and preservation of palynomorphs, and potentially address concerns surrounding possibilities

the peat is eroded and redeposited. Radiocarbon dating will be of little value In the event data suggests the peat is eroded and redeposited.

Stage 2

7.4.7 The results of XRF scanning and pollen analysis will be discussed at a future stakeholder meeting to decide on the scope for and need for OSL dating and radiocarbon dating.

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Appendix 1: Green Wall: Rotary and Sonic

Zone C

Site Code: 241532	**Site Name:** Lydd Ranges Area C	**Borehole ID:** C01/WA-S03 (Retained)
Coordinates (NGR) X: 599762.9154	**Coordinates (NGR) Y:** 117937.3959	**Level (top):** 6.46m OD
Length:	**Width:**	**Depth:** 13.5m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
3001	Mid orangey brown silty clay, very compact, structureless, Fe mottling, rounded flint/chert pebbles @1.65 (1cm), becoming mid grey brown and more pebbly, gradual lower boundary	Alluvium	1.20-3.40	5.26 – 3.06	Retained
3002	Mid grey silty clay with some Fe mottling, frequent organics (anaerobic conditions), minerogenic peat @5.65-5.68, compact, structureless		3.40-7.18	3.06 – -0.72	
3003	Mid bluish grey silty sand, banded, relatively compact, sharp lower boundary		7.18-7.40	-0.72 – -0.94	* Potential for OSL Retained
3004	Grey and orange subrounded to rounded gravels, clast supported, 0.5-2cm in size becoming finer from 8m (<0.5-2cm) subangular to subrounded, loose	Beach gravels	7.40-9.00	-0.94 – -2.54	Retained
	No sample	No recovery	9.0–12.0	-2.54 - -5.54	
3005	Firm grey poorly sorted sandy gravel, SR/R <0.04m	Sands and gravels	12.0 – 12.72	-5.54 – -6.26	Retained
3006	Firm fine grey sand with occasional shell fragments and small <0.01m SA/SR gravels towards base of unit.	Pre-barrier nearshore sands	12.72 – 13.03	-6.26 - -6.57	
3007	Soft very dark grey silty clay, no visible structure, sharp lower boundary	Pre-barrier nearshore sands	13.03 - 13.27	-6.57 - -6.81	
3008	Soft grey sand, no visible structure	Pre-barrier nearshore sands	13.27 – 13.5	-6.81 - -7.04	

Zone E

Site Code: 241532	**Site Name:** Lydd Ranges Area E	**Borehole ID:** E01/WA-SO2 (Retained)
Coordinates (NGR) X: 600204.7072	**Coordinates (NGR) Y:** 117869.7415	**Level (top):** 6.53m OD
Length:	**Width:**	**Depth:** 15.00m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2001	N/A	Void	1.20-1.30	5.33 – 5.23	Retained
2002	Light yellowish brown silty clay, frequent inclusions of CBM and grit inclusions (1cm in size) and subangular at top. Redeposited?	Redeposited alluvium?	1.30-1.85	5.23 – 4.68	
2003	Light orange brown silty clay with occasional rounded pebbles (1cm) at the top, Fe mottling, no visible structure, becomes mottled from 2.00, fragment of peat @2.65, organic band @3.10-3.20 (aerobic conditions), gradual lower boundary	Alluvium	1.85-3.40	4.68 – 3.13	
2004	Light greenish grey silty clay, Fe mottling, whole molluscs @3.50, dark organics @4.50, occasional subrounded pebbles (1cm) from 4.60-4.80, no visible structure, (anaerobic conditions), sharp lower boundary		3.40-5.30	3.13 – 1.23	
2005	Gravels, 2-5cm becoming finer (0.5-2 cm) from 5.63, rounded, orange and grey, loose, clast supported Fine to medium grey sand from 10.5 – 11.12m	Beach gravels	5.30-10.5	1.23 – -3.97	Retained to 6.5 mbgl
2006	Firm grey sandy gravel. Poorly sorted SA/SR <0.03m	Sands and gravels	10.5 – 13.11	-3.97 - -6.58	Retained * suitable for OSL
2007	Firm dark grey sand, occasional SR/R gravel <0.04m, poorly sorted becoming silty clay from 13.33m – 13.38m becoming coarser from 13.38m – 13.39m	Pre-barrier nearshore sands	13.11 – 13.39	-6.58 – -6.86	Retained to 13.5 mbgl
2008	Firm fine-medium grey brown sand, no visible structure, v occasional small <0.02m SR gravel Thin dark grey clay band at 13.62m Clear irregular lower boundary	Pre-barrier nearshore sands	13.39 - 14.33	-6.86 - -7.80	
2009	Dark grey soft silt clay with no visible structure	Pre-barrier nearshore sands	14.33 – 14.43	-7.80 – -7.90	
20010	Dark grey sand, rare small <0.01m SA gravel inclusions, no visible structure	Pre-barrier nearshore sands	14.43 – 15.0	-7.90 - -8.47	

Zone G

Site Code: 241532	**Site Name:** Lydd Ranges Area G	**Borehole ID:** G01/WA-S01 (Retained)
Coordinates (NGR) X: 600754.5844	**Coordinates (NGR) Y:** 117785.3071	**Level (top):** 13.50m OD
Length:	**Width:**	**Depth:** 10.50m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1001	Orange coarse sands and gravels (5:95), subrounded and rounded flint/chert, 0.5-2cm, loose, becoming finer to grit sized gravels (<1cm), gradual lower boundary	Sands and gravels	1.20-1.57	5.30 – 4.93	Retained
1002	Mid grey silty clay, frequent grit inclusions, structureless, subrounded pebble inclusions (1cm) from 1.63, compact, no visible lower boundary	Alluvium	1.57-2.00	4.93 – 4.50 -	
	Missing	No recovery	2.00-3.00	4.50 – 3.50	
1003	Mid orangey brown silty clay, occasional pebbles of flint/chert, 0.5-3cm, rounded, peat fragment @3.55, large fragment of peat @ 3.80-3.82, organic band at 3.70-3.86, frequent gravels 3.63-3.70.	Alluvium	3.00-3.97	3.50 – 2.53	
1004	Mid greyish brown silty clay, structureless, Fe mottling between 4-30-5.30, mineralised root from 5.65-5.78, compact, relatively sharp lower boundary		3.97-5.78	2.53 – 0.72	
1005	Mid greyish brown silty clay with bands (<1cm) of fine sand, compact, sharp lower boundary		5.78-6.00	0.72 – 0.50	* Potential for OSL Retained
1006	Mid greyish brown silty clay with dark bands of mineralised organics, rare shell fragments, poorly structured, sharp lower boundary		6.00-6.65	0.50 – -0.15	Retained
1007	Orange and grey subrounded and rounded gravels, ranging from 1-7cm, clast supported, loose, gradual lower boundary	Beach gravels	6.65-7.50	-0.15 – -1.0	
1008	Grey flint cobbles, rounded, 3-8cm, clast supported, gradual lower boundary		7.50-8.20	-1.0 – -1.7	
1009	Grey subrounded to rounded gravels 1-3cm in size becoming gradually finer from 9.95-10.18 (0.5-2cm in size) then Inc in size again to cobbles at base (3-5cm) in size, subrounded to rounded flint		8.20 10.50	-1.7 – -4.0 –	

	No sample	No recovery	10.5 – 12.11	-4.0 – -5.61	
1010	Firm grey medium – coarse sand, occasional SA/SR gravel inclusions >0.04m, occasional shell fragment, clear irregular lower boundary.	Sand and gravel	12.11 – 12.85	-5.61 – -6.35	Retained from 12.5 mbgl
1011	Firm dark grey sandy silt feint light/dark banding, sand is fine. Clear lower boundary	Pre-barrier nearshore sands	12.85 – 13.0	-6.35 – -6.5	
1012	Firm brown fine-medium sand with no visible structure	Pre-barrier nearshore sands	13.0 - 13.40	-6.5 – -6.1	
	Missing	No recovery	13.40 – 13.50		

Appendix 2: Inter-ridge marsh, hand-held window samples

Zone C

Site Code: 214532	**Site Name: Lydd Ranges (Area C)**	**Borehole ID: HHWS121**
Coordinates (NGR) X: 599891.508	**Coordinates (NGR) Y: 117998.563**	**Level (top): 1.78**
Length:	**Width:**	**Depth: 1 m**

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m aOD**	**Samples**
2101	Void	AZCL	0 - 0.10	1.78 – 1.68	
2102	Dark grey brown clayey gravel. SR/R flint	Shingle	0.10 - 0.46	1.68 – 1.32	
2103	Light brown clayey gravel SR/R flint	Shingle	0.46 - 1.0	1.32 – 0.78	

Site Code: 214532	**Site Name: Lydd Ranges (Area C)**	**Borehole ID: HHWS122**
Coordinates (NGR) X: 599864.563	**Coordinates (NGR) Y: 117967.784**	**Level (top): 2.25m OD**
Length:	**Width:**	**Depth: 1 m**

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m aOD**	**Samples**
2201	Void	AZCL	0 – 0.2	2.25 – 2.05	
2202	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.2 - 0.9	2.05 – 1.35	
2203	Grey gravelly clay, SR/R flint	Shingle	0.9 - 1.0	1.35 – 1.25	

Site Code: 214532	**Site Name: Lydd Ranges (Area C)**	**Borehole ID: HHWS123**
Coordinates (NGR) X: 599856.503	**Coordinates (NGR) Y: 117945.982**	**Level (top): 1.76m OD**
Length:	**Width:**	**Depth: 1 m**

Context Number	**Description**	**Interpretation**	**Depth m BGL**	**Depth m aOD**	**Samples**
2301	Void	AZCL	0 – 0.2	1.76 – 1.56	
2302	Stiff Fe mottled dark grey silty clay	Inter-ridge marsh deposits	0.2 - 0.33	1.56 – 1.43	
2303	Dark grey clayey gravel	Shingle	0.33 - 1.0	1.43 – 0.76	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS124
Coordinates (NGR) X: 599830.207	Coordinates (NGR) Y: 117951.296	Level (top): 1.72m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2401	Grey clayey gravel (no recovery)	Shingle	0 – 1.0	1.72 – 0.72	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS125 (Retained)
Coordinates (NGR) X: 599802.682	Coordinates (NGR) Y: 117947.336	Level (top): 2.07m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2501	Grey gravelly clay	Inter-ridge deposits	0 – 1.0	2.07 – 1.07	Retained
2502	Grey clayey gravel (void	Shingle	1.0- 2.0	1.07 – 0.07	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS126
Coordinates (NGR) X: 599780.822	Coordinates (NGR) Y: 117951.066	Level (top): 2.25m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2601	Grey gravelly clay	Shingle	0 – 0.4	2.25 – 1.85	
2602	Firm grey silty clay	Inter-ridge deposits	0.4 - 1.0	1.85 – 1`.25	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS127
Coordinates (NGR) X: 599741.972	Coordinates (NGR) Y: 117959.043	Level (top): 1.66m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2701	Void	AZCL	0 - 0.05	1.66 – 1.61	
2702	Dark grey brown slightly gravelly clay	Inter-ridge deposits	0.05 - 0.12	1.61 – 1.54	
2703	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.12 - 1.0	1.54 – 0.66	
2704	Void	AZCL	1.0 - 1.2	0.66 – 0.46	
2705	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	1.2 - 2.0	0.46 – -0.34	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS128
Coordinates (NGR) X: 599704.573	Coordinates (NGR) Y: 117967.892	Level (top): 1.73m OD
Length:	Width:	Depth: 1m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2801	Grey brown gravelly clay (no recovery)	Inter-ridge deposits	0 – 1.0	1.73 – 0.73	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS129
Coordinates (NGR) X: 599691.979	Coordinates (NGR) Y: 117998.154	Level (top): 1.68m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2901	Void	AZCL	0 - 0.15	1.68 – 1.53	
2902	Brown gravelly clay SR/R flint	Inter-ridge deposits	0.15 - 0.25	1.53 – 1.43	
2903	Stiff brown Fe mottled silty clay	Inter-ridge deposits	0.25 - 0.63	1.43 – 1.05	
2904	Brown clayey gravel	Shingle	0.63 - 1.0	1.05 – 0.68	

Site Code: 214532	Site Name: Lydd Ranges (Area C)	Borehole ID: HHWS130
Coordinates (NGR) X: 599706.115	Coordinates (NGR) Y: 118025.043	Level (top): 1.74m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
3001	Void	AZCL	0 – 0.2	1.74 – 1.54	
3002	Grey brown gravelly clay	Inter-ridge deposits	0.2 - 0.38	1.52 – 1.36	
3003	Firm grey/dark grey silty clay	Inter-ridge deposits	0.38 - 0.95	1.36 – 0.79	
3004	Dark grey gravelly clay	Shingle	0.95 - 1.0	0.79 – 0.74	

Zone E

Site Code: 214532	**Site Name: Lydd Ranges (Area E)**	**Borehole ID: HHWS111**
Coordinates (NGR) X: 600143.642	**Coordinates (NGR) Y: 117943.085**	**Level (top): 2.00m OD**
Length:	**Width:**	**Depth: 2 m**

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1101	Dark brown gravelly silty clay	Topsoil	0 - 0.06	2.00 – 1.94	
1102	Stiff dark grey silty clay, evidence of lamination, mottled at top of unit	Inter-ridge marsh deposits	0.06 - 1.7	1.94 – 0.3	
1103	SR/R flint gravels in a grey silty clay matrix	Shingle	1.7 - 2.0	0.3 – 0.0	

Site Code: 214532	**Site Name: Lydd Ranges (Area E)**	**Borehole ID: HHWS112**
Coordinates (NGR) X: 600114.044	**Coordinates (NGR) Y: 117927.697**	**Level (top): 1.90m OD**
Length:	**Width:**	**Depth: 1.0m**

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1201	SR/R flint gravels in a grey silty clay matrix	Shingle	0 – 1.0	1.90 – 0.9	

Site Code: 214532	**Site Name: Lydd Ranges (Area E)**	**Borehole ID: HHWS113**
Coordinates (NGR) X: 600097.832	**Coordinates (NGR) Y: 117907.286**	**Level (top): 1.87m OD**
Length:	**Width:**	**Depth: 2 m**

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1301	Dark brown gravelly silty clay	Topsoil	0 – 0.1	1.87 – 1.77	
1302	Grey clayey gravel SR/R flint	Shingle migration over inter-ridge marsh deposits	0.1 - 0.5	1.77 – 1.37	
1303	Stiff dark grey silty clay, evidence of lamination, mottled at top of unit	Inter-ridge marsh deposits	0.5 - 1.95	1.37 – -0.05	
1304	SR/R flint gravels in a grey silty clay matrix	Shingle	1.95 - 2.0	-0.05 – -0.10	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS114 (Retained)
Coordinates (NGR) X: 600111.138	Coordinates (NGR) Y: 117900.658	Level (top): 2.27m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1401	Dark brown silty clay	Topsoil	0 – 0.2	2.27 - 2.07	Retained
1402	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.2 - 0.6	2.07 – 1.67	
1403	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	0.6 - 2.0	1.67 – 0.27	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS115
Coordinates (NGR) X: 600143.894	Coordinates (NGR) Y: 117895.005	Level (top): 2.28m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1501	Void	AZCL	0 – 0.2	2.28 – 2.08	
1502	Dark brown silty clay	Topsoil	0.2 - 0.25	2.08 – 2.03	
1503	Stiff disturbed greey silty clay with gravels (1.0 - 2.0 no recovery)	Green bank	0.25 - 1.0	2.03 – 1.28	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS116
Coordinates (NGR) X: 600252.092	Coordinates (NGR) Y: 117884.662	Level (top): 1.69m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1601	Grey brown clayey gravel SR/R flints (1.0 - 2.0) no recovery		0 – 1.0	1.69 – 0.69	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS117
Coordinates (NGR) X: 600277.156	Coordinates (NGR) Y: 117879.91	Level (top): 1.78m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1701	grey brown clayey gravel SR/R flint	Shingle	0 – 1.0	1.78 – 0.78	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS118
Coordinates (NGR) X: 600301.773	Coordinates (NGR) Y: 117877.532	Level (top): 1.68m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1801	Grey brown clayey gravel SR/R flint	Shingle	0 – 1.0	1.68 – 0.68	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS119
Coordinates (NGR) X: 600297.672	Coordinates (NGR) Y: 117901.548	Level (top): 1.79 m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1901	Grey brown clayey gravel SR/R flint	Shingle	0 – 1.0	1.79 – 0.79	

Site Code: 214532	Site Name: Lydd Ranges (Area E)	Borehole ID: HHWS120
Coordinates (NGR) X: 600316.998	Coordinates (NGR) Y: 117922.399	Level (top): 1.66m OD
Length:	Width:	Depth: 1 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
2001	Grey brown clayey gravel flint SR/R	Shingle	0 – 1.0	1.66 – 0.66	

Zone G

Site Code: 214532	**Site Name: Lydd Ranges (Area G)**	**Borehole ID: HHWS101**
Coordinates (NGR) X: 600780.664	**Coordinates (NGR) Y: 117831.259**	**Level (top): 1.82 m OD**
Length:	**Width:**	**Depth: 2 m**

Context Number	Description	Interpretation	Depth m BGL	Depth m OD	Samples
101	Dark brown well rooted silty clay	Topsoil	0 – 0.3	1.82 – 1.52	
102	Grey gravelly silty clay, SR gravels <0.03m	Shingle bank	0.3 – 2.0	1.52 – -0.18	

Site Code: 214532	**Site Name: Lydd Ranges (Area G)**	**Borehole ID: HHWS102**
Coordinates (NGR) X: 600787.72	**Coordinates (NGR) Y: 117813.694**	**Level (top): 1.76m OD**
Length:	**Width:**	**Depth: 2 m**

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
201	Dark brown silty gravelly clay	Topsoil	0 - 0.10	1.76 – 1.66	
202	Stiff grey silty clay Fe mottled towards top of unit	Inter-ridge marsh deposit	0.10 - 0.73	1.66 – 1.03	
203	Stiff finely laminated grey silty clay	Inter-ridge marsh deposit	0.73 - 1.0	1.03	
204	Fine SR/R flint gravels	Shingle	1.0 - 2.0	0.76 - -0.24	

Site Code: 214532	**Site Name: Lydd Ranges (Area G)**	**Borehole ID: HHWS103**
Coordinates (NGR) X: 600772.511	**Coordinates (NGR) Y: 117807.128**	**Level (top): 1.76m OD**
Length:	**Width:**	**Depth: 2 m**

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
301	Stiff dark brown silty clay	Topsoil	0 – 0.2	1.76 – 1.56	
302	Stiff grey silty clay Fe mottled towards top of unit	Inter-ridge marsh deposits	0.2 - 0.7	1.56 – 1.06	
303	Stiff grey laminated silty clay	Inter-ridge marsh deposits	0.7 - 2.0	1.06 – -0.24	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS104 (retained)
Coordinates (NGR) X: 600748.701	Coordinates (NGR) Y: 117806.767	Level (top): 1.74m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
401	Dark brown silty clay	Topsoil	0 - 0.10	1.74 – 1.64	Retained
402	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.10 - 0.5	1.64 – 1.24	
403	Void	A.Z.C.L.	0.5 - 1.0	1.24 – 0.74	
404	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	1.0 - 2.0	0.74 – -0.26	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS105
Coordinates (NGR) X: 600732.241	Coordinates (NGR) Y: 117814.687	Level (top): 1.73m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
501	Dark brown silty clay, well rooted	Topsoil	0 - 0.12	1.73 – 1.61	
502	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.12 - 0.7	1.61 – 1.03	
503	Void	AZCL	0.7 - 1.0	1.03 – 0.73	
504	Stiff grey silty clay with evidence of laminations and remains of marine molluscs	Inter-ridge marsh deposits	1.0 - 2.0	0.73 – 0.27	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS106
Coordinates (NGR) X: 600685.86	Coordinates (NGR) Y: 117821.76	Level (top): 1.77m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
601	Dark brown silty clay, well rooted	Topsoil	0 - 0.12	1.77 – 1.65	
602	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.12 - 0.6	1.65 – 1.16	
603	Void	AZCL	0.6 - 1.0	1.16 – 0.77	
604	Stiff grey silty clay with evidence of laminations and remains of marine molluscs	Inter-ridge marsh deposits	1.0 - 2.0	0.77 – -0.23	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS107 (0-1.0m retained)
Coordinates (NGR) X: 600660.769	Coordinates (NGR) Y: 117823.976	Level (top): 2.0m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
701	Dark brown silty clay	Topsoil	0 - 0.10	2.0 – 1.9	Retained
702	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.10 - 0.59	1.9 – 1.41	
703	Soft very dark brown silty clay with abundant fine organic material	Peat	0.59 - 0.97	1.41 – 1.03	
704	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	0.97 - 1.0	1.03 – 1.0	
705	Void	AZCL	1.0 - 1.75	1.0 – 0.25	
706	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	1.75 - 2.0	0.25 – 0.0	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS108
Coordinates (NGR) X: 600676.205	Coordinates (NGR) Y: 117833.481	Level (top): 1.85m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
801	Dark brown silty clay	Topsoil	0 - 0.10	1.85 – 1.75	
802	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.10 - 0.65	1.75 – 1.20	
803	Void	AZCL	0.65 - 1.0	1.20 – 0.85	
804	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	1.0 - 2.0	0.85 – -0.15	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS109
Coordinates (NGR) X: 600669.839	Coordinates (NGR) Y: 117848.116	Level (top): 1.93m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
901	Dark brown silty clay	Topsoil	0 - 0.10	1.93 – 1.83	
902	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.10 - 0.65	1.83 – 1.28	
903	Void	AZCL	0.65 - 1.0	1.28 – 0.93	
904	Stiff dark grey silty clay, evidence of lamination	Inter-ridge marsh deposits	1.0 - 2.0	0.93 – 0.07	

Site Code: 214532	Site Name: Lydd Ranges (Area G)	Borehole ID: HHWS110
Coordinates (NGR) X: 600672.301	Coordinates (NGR) Y: 117868.137	Level (top): 1.96m OD
Length:	Width:	Depth: 2 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
1001	Dark brown silty clay	Topsoil	0 - 0.10	1.96 – 1.86	
1002	Stiff Fe mottled grey silty clay	Inter-ridge marsh deposits	0.10 - 0.5	1.86 – 1.46	
1003	Stiff dark grey silty clay, evidence of lamination (1.0 - 2.0 no recovery)	Inter-ridge marsh deposits	0.5 - 2.0	1.46 – 0.04	

Appendix 3: Beach Works, foreshore scrapes

Zone C

Site Code: 241532	**Site Name:** Lydd Ranges	**Test Pit ID:** 1 (Zone C)
Coordinates (NGR) X:	**Coordinates (NGR) Y:**	**Level (top):**
Length: 1.90 m	**Width:** 1.80 m	**Depth:** 1.20 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
11	Fine to coarse sand with occasional to moderate small-large rounded and sub-rounded pebbles and stones	Beach sand with shingle inclusions	0-0.80	+2.22 to +1.42	
12	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0.80-1.20	+1.42 to +1.02	
13	Fairly firm black silt	Organic silt	1.20+	+1.02+	

Zone E

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 2 (Zone E)
Coordinates (NGR) X: 600236.9972	Coordinates (NGR) Y: 117784.7247	Level (top): -1.6084
Length: 1.90 m	Width: 1.50 m	Depth: 0.30 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
21	frequent small to large rounded and sub-rounded pebbles and stones, occasional to moderate small to large rounded and sub-rounded cobbles clast supported when sediment appears - friable sand (fine to coarse)	beach shingle	0-0.30	-0.78 to -1.08	
22	fairly firm black silt	organic silt	0.30+	-1.08+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 3 (Zone E)
Coordinates (NGR) X: 600235.7415	Coordinates (NGR) Y: 117784.6403	Level (top): 1.0764
Length: 1.90 m	Width: 1.50 m	Depth: 0.30 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
31	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.30	-0.82 to -1.12	
32	Fairly firm black silt	Organic silt	0.30-0.90	-1.12 to -1.72	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 13 (Zone E)
Coordinates (NGR) X: 600234.8264	Coordinates (NGR) Y: 117791.9498	Level (top): 0.0274
Length: 1.90 m	Width: 1.80 m	Depth: 0.70 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
131	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.70	0 to -0.70	
132	Fairly firm black silt	Organic silt	0.70+	-0.70+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 14 (Zone E)
Coordinates (NGR) X: 600228.1156	Coordinates (NGR) Y: 117793.7211	Level (top): 0.0872
Length: 1.90 m	Width: 1.80 m	Depth: 0.70 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
141	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.70	+0.37 to -0.33	
142	Fairly firm black silt	Organic silt	0.70+	-0.33+	

Zone G

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 4 (Zone G)
Coordinates (NGR) X: 600232.7649	Coordinates (NGR) Y: 117785.3261	Level (top): -1.07
Length: 1.90 m	Width: 1.50 m	Depth: 0.30 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
41	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.30	-0.79 to -1.09	
42	Fairly firm black silt	Organic silt	0.30+	-1.09+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 5 (Zone G)
Coordinates (NGR) X: 600748.8119	Coordinates (NGR) Y: 117693.1981	Level (top): -0.1612
Length: 1.90 m	Width: 1.80 m	Depth: 0.70 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
51	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.60	-0.16 to -0.76	
52	Fairly firm black silt	Organic silt	0.60+	-0.76+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 6 (Zone G)
Coordinates (NGR) X: 600741.6063	Coordinates (NGR) Y: 117696.0861	Level (top): 0.0029
Length: 1.90 m	Width: 1.80 m	Depth: 0.80 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
61	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.70	0 to -0.70	
62	Fairly firm black silt	Organic silt	0.70+	-0.70+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 7 (Zone G)
Coordinates (NGR) X: 600737.2133	Coordinates (NGR) Y: 117699.8684	Level (top): 0.3575
Length: 1.90 m	Width: 1.80 m	Depth: 0.80 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
71	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.80	+0.36 to -0.44	
72	Fairly firm black silt	Organic silt	0.80+	-0.44+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 8 (Zone G)
Coordinates (NGR) X: 600732.2423	Coordinates (NGR) Y: 117703.2514	Level (top): 0.6548
Length: 1.90 m	Width: 1.80 m	Depth: 0.80 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
81	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.80	+0.69 to -0.11	
82	Fairly firm black silt	Organic silt	0.80	-0.11+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 9 (Zone G)
Coordinates (NGR) X: 600746.9638	Coordinates (NGR) Y: 117686.3892	Level (top): -1.0706
Length: 1.90 m	Width: 1.80 m	Depth: 0.60 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
91	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.60	-0.85 to -1.45	
92	Fairly firm black silt	Organic silt	0.60+	-1.45+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 10 (Zone G)
Coordinates (NGR) X: 600740.5202	Coordinates (NGR) Y: 117687.0309	Level (top): -1.2356
Length: 1.90 m	Width: 1.80 m	Depth: 0.60 m

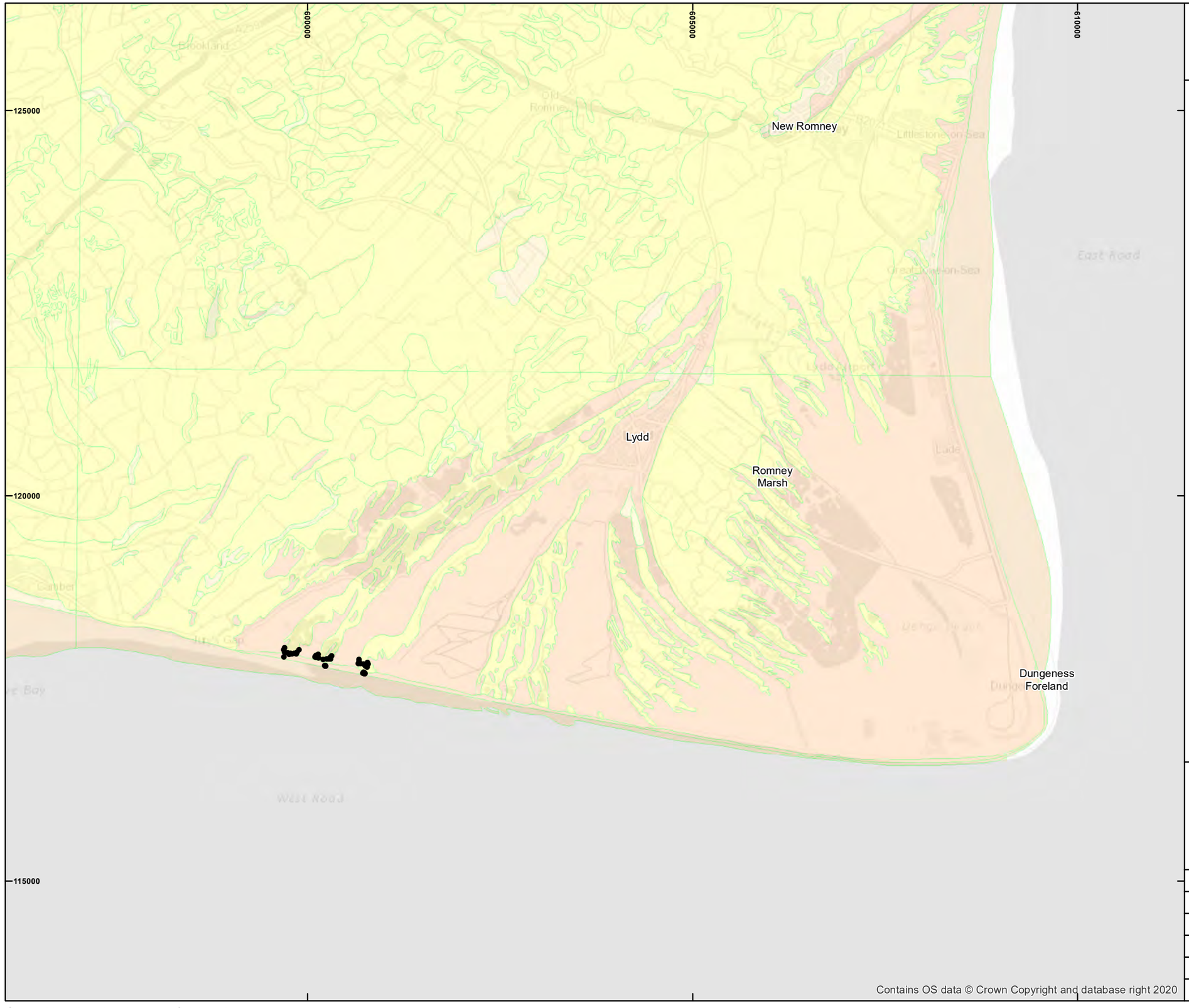
Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
101	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.60	-0.80 to -1.40	
102	Fairly firm black silt	Organic silt	0.60+	-1.40+	

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 11 (Zone G)
Coordinates (NGR) X: 600734.3667	Coordinates (NGR) Y: 117696.4768	Level (top): -0.1316
Length: 1.90 m	Width: 1.80 m	Depth: 0.90 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
111	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.80	-0.13 to -0.93	
112	Fairly firm black silt	Organic silt	0.80-1.30	-0.93 to -1.43	111 - monolith

Site Code: 241532	Site Name: Lydd Ranges	Test Pit ID: 12 (Zone G)
Coordinates (NGR) X: 600719.6323	Coordinates (NGR) Y: 117696.101	Level (top): -1.2928
Length: 1.90 m	Width: 1.80 m	Depth: 0.90 m

Context Number	Description	Interpretation	Depth m BGL	Depth m aOD	Samples
121	Frequent small-large rounded and sub-rounded pebbles and stones, occasional to moderate small-large rounded and sub-rounded cobbles Clast supported - sediment is friable sand (fine to coarse)	Beach shingle	0-0.80	-0.44 to -1.24	
122	Fairly firm black silt	Organic silt	0.80+	-1.24+	



- Borehole location

Superficial Geology

- Alluvium - clay, silt, sand and peat
- Blown sand - sand
- Storm beach deposits - gravel
- Beach and tidal flat deposits (undifferentiated) - clay, silt, sand and gravel
- Tidal flat deposits - sand
- Peat - peat

0 2,000 m

Coordinate system:
OSGB36 (OSTN02/OSGM02)
OSGB36 (OSTN15/OSGM15)

Date:	03/11/2021
Revision Number:	0
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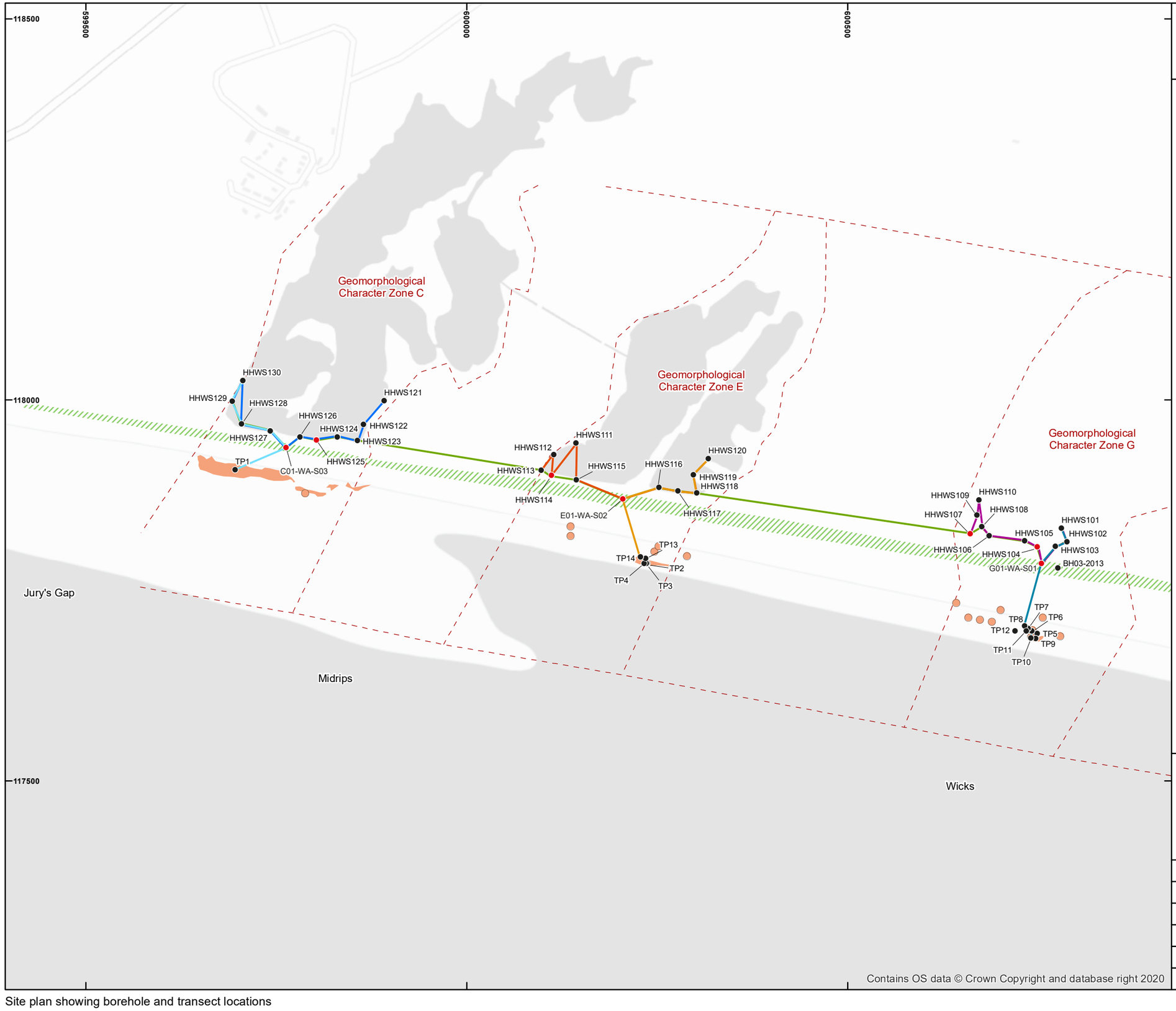
	FigsMXD\2021_11_01

General location showing superficial geology

Figure 1



- Borehole location
- Borehole location (retained or partially retained)
- Transect C (North to South)
- Transect C (West to East)
- Transect E (North to South)
- Transect E (West to East)
- Transect G (North to South)
- Transect G (West to East)
- Transect C to G
- Intertidal clay exposure (point)
- Intertidal clay exposure
- Geomorphological Character Zone
- Green Wall

0 250 m

Coordinate system:
OSGB36 (OSTN02/OSGM02)
OSGB36 (OSTN15/OSGM15)

Date:	03/11/2021
Revision Number:	0
Scale:	1:5,000 at A3
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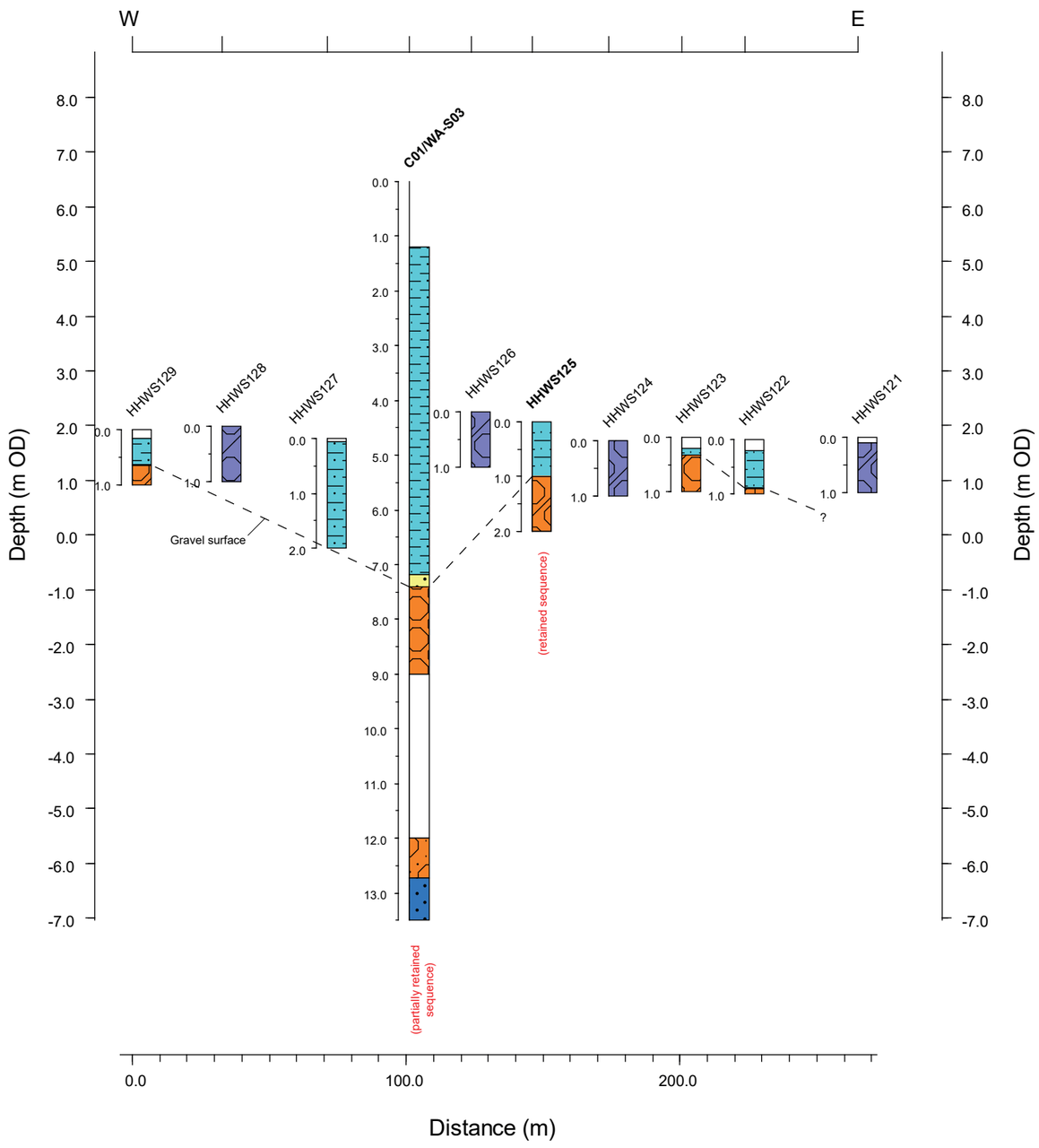
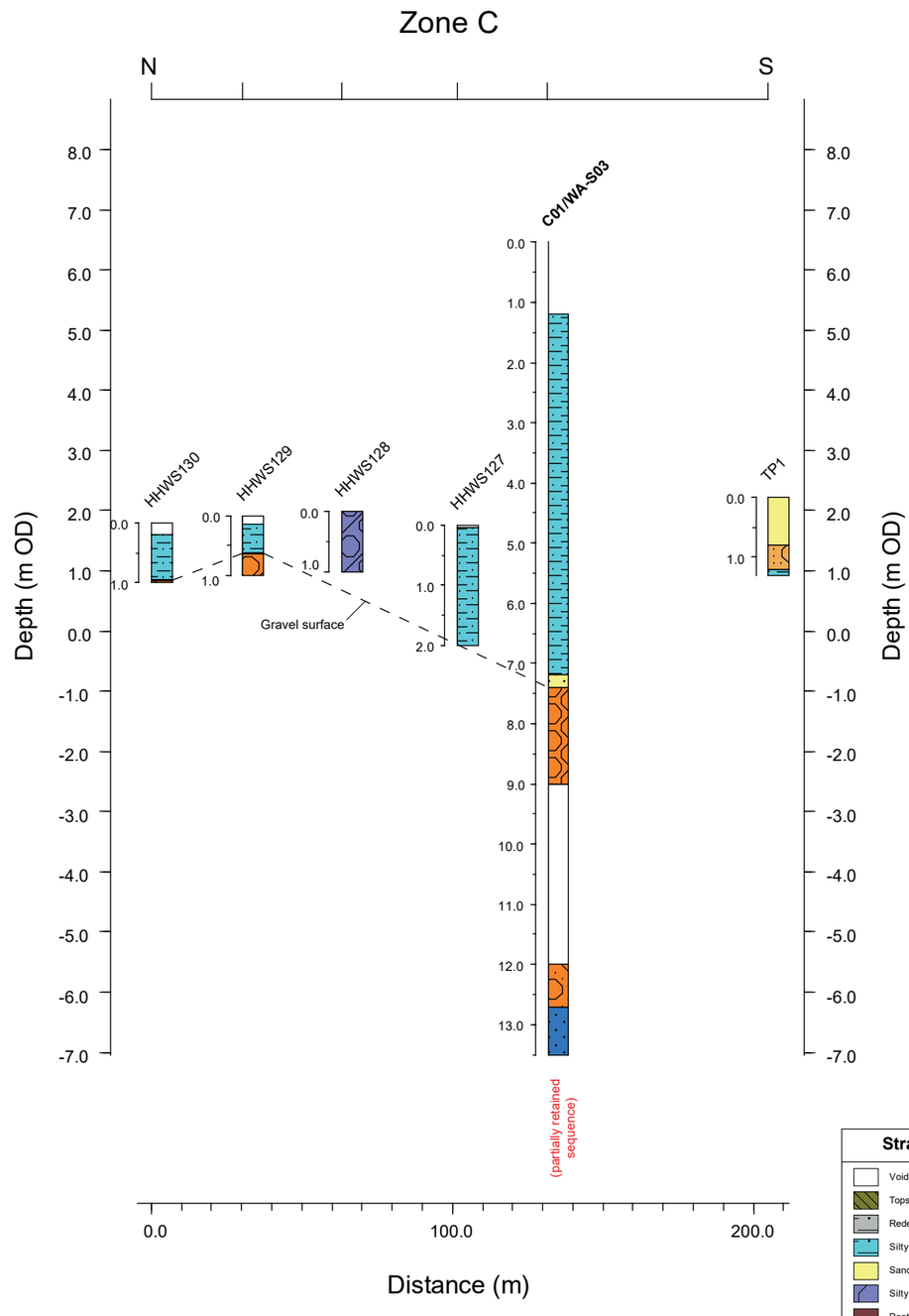
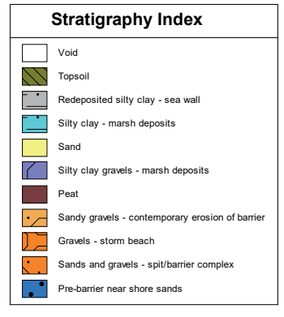
	FigsMXD\2021_11_01

Site plan showing borehole and transect locations

Figure 2







Note: Gravel surface only plotted between HHWS comprising clayey-gravels underlying fine-grained marsh deposits. No evidence for underlying stratigraphy in those HHWS refusing on near-surface gravels at 1 mblg.

Date:	01/11/2021	Revision Number:	0
Scale:	Not to scale	Illustrator:	AW
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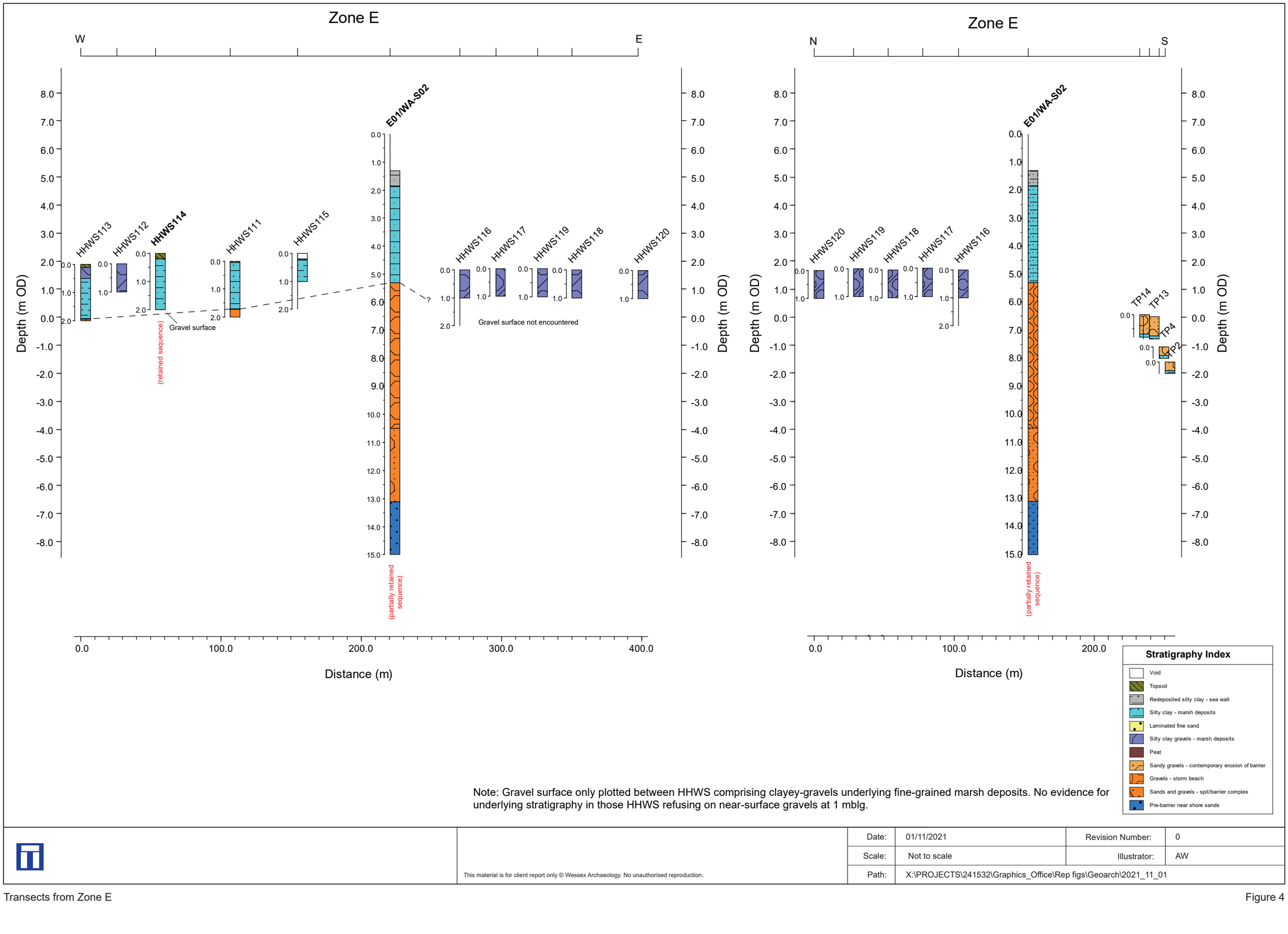
Transects from Zone C

Figure 3



Note: Gravel surface only plotted between HHWS comprising clayey-gravels underlying fine-grained marsh deposits. No evidence for underlying stratigraphy in those HHWS refusing on near-surface gravels at 1 mblg.

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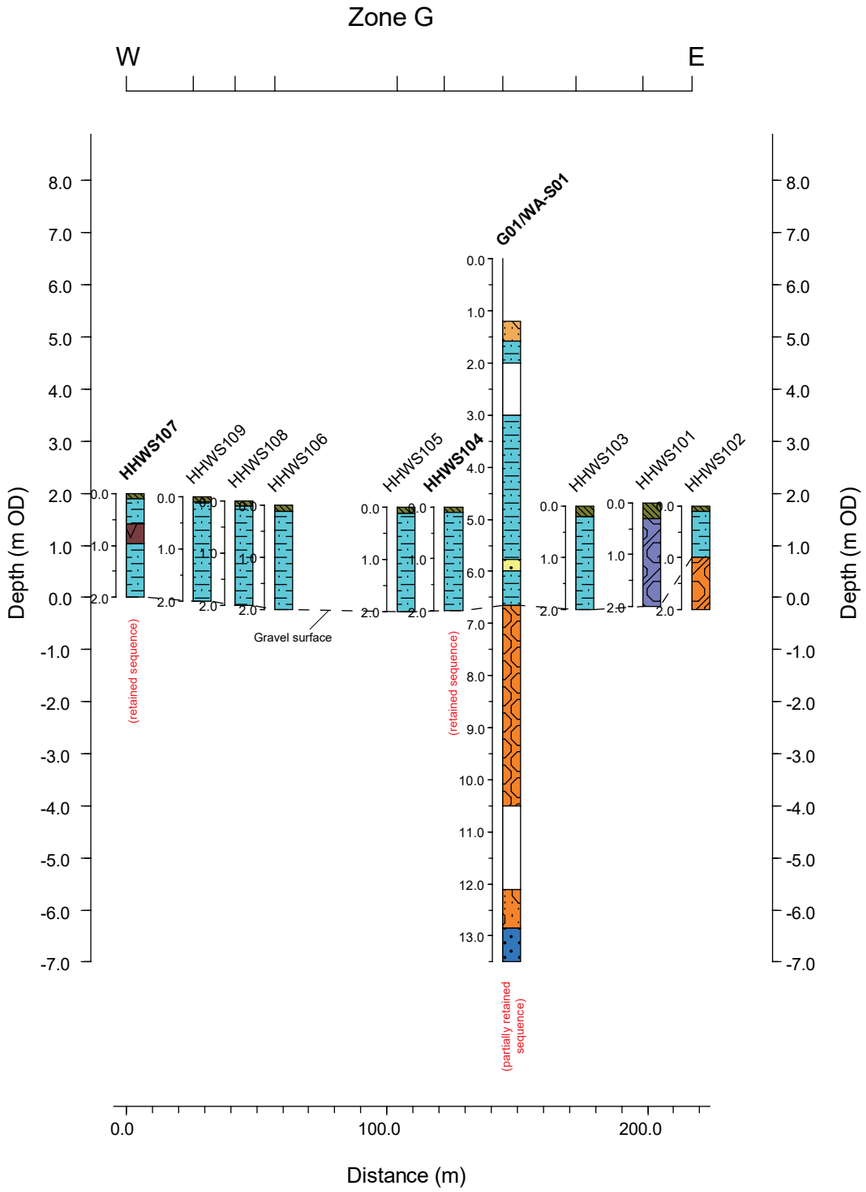
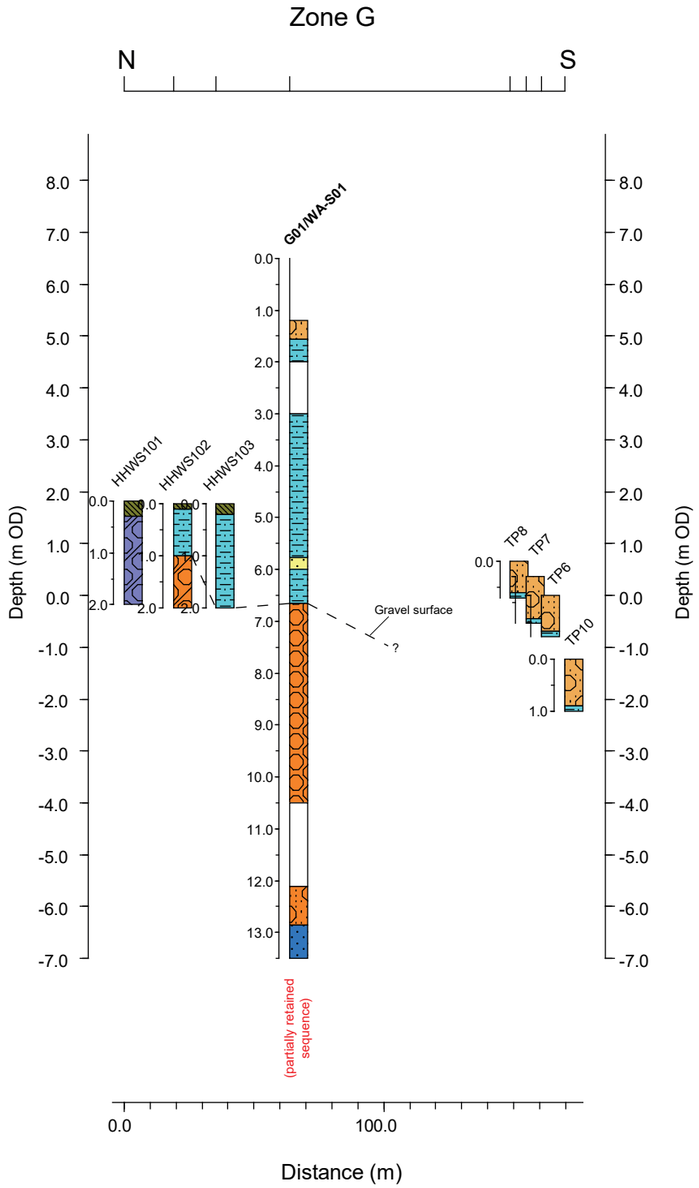
Transects from Zone E

Figure 4





Stratigraphy Index

- Void
- Topsoil
- Redeposited silty clay - sea wall
- Silty clay - marsh deposits
- Laminated fine sand
- Silty clay gravels - marsh deposits
- Peat
- Sandy gravels - contemporary erosion of barrier
- Gravels - storm beach
- Sands and gravels - spit/barrier complex
- Pre-barrier near shore sands

Note: Gravel surface only plotted between HHWS comprising clayey-gravels underlying fine-grained marsh deposits. No evidence for underlying stratigraphy in those HHWS refusing on near-surface gravels at 1 mblg.

Date:	01/11/2021	Revision Number:	0
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Transects from Zone G

Figure 5

Zone C

Zone E

Zone G

W

E

Depth (m OD)

Gravel surface

Base of gravel

(partially retained sequence)

(retained sequence)

C01/WA-S03

E01/WA-S02

G01/WA-S01

HHWS129

HHWS128

HHWS127

HHWS126

HHWS125

HHWS124

HHWS123

HHWS113

HHWS114

HHWS115

HHWS116

HHWS117

HHWS118

HHWS107

HHWS108

HHWS106

HHWS105

HHWS104

HHWS103

HHWS102

Stratigraphy Index

- Void/no recovery
- Topsoil
- Redeposited silty clay - sea wall
- Silty clay - marsh deposits
- Laminated fine sand
- Silty clay gravels - marsh deposits
- Peat
- Sandy gravels - contemporary erosion of barrier
- Gravels - storm beach
- Sands and gravels - spit/barrier complex
- Pre-barrier near shore sands

Distance (m)

Note: Gravel surface only plotted between HHWS comprising clayey-gravels underlying fine-grained marsh deposits. No evidence for underlying stratigraphy in those HHWS refusing on near-surface gravels at 1 mblg.

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Wessex Archaeology Ltd registered office Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB
Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk www. wessexarch.co.uk

FS 606559