Dartford
Kent
Dartford Fastrack Scheme: Section C

Geo-archaeological report on test pits and bulk gravel extraction

oxfordarchaeology

May 2006

Client: Kent County Council

Issue N^{O}: 1
OA Job N^{O}: JN 2489
NGR: TQ 5546 1738

Client Name: Kent County Council

Client Ref No:

Document Title: Dartford Fastrack Scheme Section C. Geo-archaeological report on test pits and bulk gravel extraction.

Document Type: Archaeological Investigation Report

Issue Number: Final Report (1)

National Grid Reference: NGR TQ 5546 1738
Planning Reference: n/a

OA Job Number: JN 2489
Site Code: DAFT 04
Invoice Code: DAFT WB1
Receiving Museum: TBC
Museum Accession No: DAFT 04

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Date: 9th May 2006

Document File Location X:\Dartford Fast Track\Geoarch work Section C\REPORT\SectionCFinalRep4thMay06Version5.doc
Graphics File Location Server10/oaupubs/a-h-DAFTEV*Dartford*jm*25.11.05
Illustrated by Julia Moxham

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DARTFORD FASTRACK (SECTION C): PALAEOLITHIC/PLEISTOCENE INVESTIGATIONS

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SUMMARY

Archaeological and geological field investigations of Section C of the Dartford Fastrack Scheme have confirmed certain aspects of the local geology and have brought to light periglacial structures not previously recorded. The investigations confirmed the local occurrence of the Dartford Heath Gravel (≈ Orsett Heath Gravel, ≈ Boyn Hill Gravel) and enabled its relationship to the gravels on Dartford Heath and at Swanscombe to be examined. Periglacial load structures of more complexity than the local involutions have been described and valley bulging is reported for the first time.

No unequivocal Palaeolithic artefacts were found, despite sieving of very large quantities of gravel. This suggests that there was no human presence in the area at the time of this deposit's formation, which perhaps implies it was not laid down at the same time as any part of the Boyn Hill Gravel sequence at Swanscombe, which is rich throughout in Palaeolithic remains.

1 INTRODUCTION

1.1 Project background

Archaeological field investigations were required by Kent County Council in advance of construction works for the Kent Thameside Fastrack scheme at Dartford (Fig. 1). Pleistocene fluvial deposits are mapped in the area of Princes Road to the A282 Junction 1B (Section C), so Palaeolithic/Pleistocene investigations were carried out along this part of the route. This archive report covers the results of both initial field evaluation and also subsequent mitigating work.

1.2 Site location and topography

The Fastrack scheme runs south from central Dartford, down the east side of the Darent Valley and then east, crossing the M25 and passing Darent Valley Hospital before descending into Bluewater shopping centre. Section C of the scheme runs east–west along Princes Road for *c.*500 m, between Darenth Road and the A282/M25 (Junction 1B), in the form of a cutting widening the existing Princes Road carriageway to the south (Fig. 2). The ground surface (at the top of the cutting) along this stretch descends westward from *c.*40 m OD to *c.*25 m OD. The base of the cutting descends from *c.*40 m OD to *c.*23 m OD, with a maximum depth of almost 10 m in the central part.

1.3 Palaeolithic and geological background

The evaluation area is located in the southern part of an area of Pleistocene deposits mapped as Boyn Hill Gravel that underlies much of Dartford. These deposits are part of a more widespread formation that is preserved on the south side of the Lower Thames in an intermittently occurring east–west trending band from Dartford Heath through Dartford centre, Stone and Greenhithe to Swanscombe and ultimately Northfleet. The deposits in the formation consist of predominantly fluviatile loam, sand and gravel units laid down by the ancient Thames. There is currently great debate over the age of these deposits, and over whether the thick deposits in the Dartford area contain a single group of deposits (Bridgland 1994) or two superimposed groups (Gibbard 1994).

According to Bridgland, the Dartford deposits represent a single major terrace aggradation dating from the end of the Anglian glaciation and the early part of the Hoxnian interglacial period between 450,000 and 350,000 BP (late marine isotope stage [MIS] 12 to early MIS 10), and are directly equivalent to the Boyn Hill/Orsett Heath deposits at Barnfield Pit, Swanscombe, *c.*5 km to the east. According to Gibbard, the thick sequence at Dartford includes two groups of deposits: an older and higher late Anglian Dartford Heath Gravel, which correlates with the Middle Thames Black Park Gravel; and a slightly lower and younger terminal Anglian and early Hoxnian member, which correlates with the Boyn Hill/Orsett Heath deposits at Swanscombe.

The Pleistocene fluvial deposits preserved between Dartford Heath and Northfleet are rich in significant Palaeolithic archaeological remains. Quarrying activity at numerous locations has produced flint artefacts, faunal remains and other biological evidence relating to climate and environment (Wymer 1968 & 1999; Roe 1981). The best-investigated sites are in the Boyn Hill/Orsett Heath deposits at Greenhithe and Swanscombe, *c.*5 km to the east, but numerous stray finds of handaxes, flakes and faunal remains have also been made in the more westerly patches of gravel towards Dartford Heath. Three find-spots of handaxes are known from the gravel deposits immediately north of Princes Road (Wessex Archaeology 1993), and one of the old quarries in this vicinity is also reported to have produced molluscan and large mammalian faunal remains (Newton 1895: 521).

Generally, the Dartford area is rich in Palaeolithic sites, and Section C of the Fastrack scheme impacted upon a Pleistocene deposit with high potential to contain Palaeolithic remains or other evidence that could help place known local sites in a better context of understanding. Consequently the archaeological programme for this section incorporated Palaeolithic/Pleistocene investigations.

1.4 Fieldwork events

The Palaeolithic/Pleistocene investigations comprised (i) an initial phase of field evaluation, followed by (ii) further investigations and recording during the construction programme (Table 1).

Event	*Scope*	*Summary details*	*Date*
DAFT04	Field evaluation	A row of deep test pits along cutting route, with sieving of spit samples for artefacts	9–12 August 2004
DAFT 04 (WB1)	Mitigating investigations during construction	Recording of sequence exposed in cutting, and sieving of bulk samples for artefacts	22 October to 1 December 2004

Table 1. *Palaeolithic/Pleistocene fieldwork events*

2 FIELD EVALUATION

2.1 Aims and objectives

The overall goals of the field evaluation were:

- To assess the nature and significance of the Pleistocene deposits and Palaeolithic remains present

- To establish the distribution and depth across the site of the Pleistocene deposits

- To assess the Palaeolithic archaeological significance of any deposits

More specifically, the work also aimed to:

- Determine the presence and potential of lithic artefact evidence and faunal remains in the sediments encountered

- Determine the presence and potential of palaeo-environmental micro-biological evidence in the sediments encountered

- Determine the presence of, or potential for, undisturbed primary context Palaeolithic occupation surfaces in the sediments encountered

- Establish the horizontal and vertical extent, sequence and sedimentological character of Pleistocene deposits across the site

- Interpret the depositional and post-depositional history of any artefactual or biological evidence found

- Establish correlations of any Pleistocene deposits found with reference to adjacent and regional sequences, and to national frameworks

- Assess in local, regional and national terms, the archaeological and geological significance of any Pleistocene deposits encountered, and their potential to fulfil current research objectives

2.2 Methods

Eight deep test pits were excavated at one end of evaluation trenches 3 to 10 (Fig. 3). The topsoil of each trench was removed over an area of 20m by 2m using a 2m wide trenching bucket down to the top of the underlying Pleistocene sediments, in most cases to a depth of approximately 0.3m. The exposed deposits were then investigated for archaeological features and deposits. Deeper test pits were then excavated at one end of each evaluation trench in order to investigate the underlying Pleistocene deposits. All test pits were of the order of 4–5m in length and initially 2m in width, dug using the trenching bucket. Below safe working depth a toothed bucket of approximately 1.2m in width was used to excavate down to Chalk bedrock, or as far as it was possible to go. The deposits were observed and recorded and a series of 100 litre samples taken and sieved through a 10mm mesh, and sorted for artefacts.

2.3 Results

2.3.1 Stratigraphy

Four major groups of deposit (i–iv) were present, although not in all test pits, corresponding to major phases of deposition (Table 2). Detailed records of the stratigraphy and attribution of sediment units to depositional groups are given for each test pit (Appendix 1). In summary, Pleistocene deposits associated with the Boyn Hill/Orsett Heath Member were present in all the test pits, thickening and deepening to the west (Fig. 4, Fig. 5 - section details). At the west end of the site (Trench 3), the base of the Boyn Hill deposits was not reached (at a depth of 32 m OD). Geotechnical borehole BH 8, *c.*200m further to the west, also failed to reach the base of the Boyn Hill deposits (at a depth of 24.3 m OD).

Interestingly, the bottom 2.5m of this borehole comprised soft orange-brown sandy clay with some fine–medium flint gravel, rather than typical loose sandy Boyn Hill gravel — the base of which occurred at 26.9 m OD. This borehole also contained a horizon *c.*1m thick of olive sandy clay between *c.*30m and 31 m OD. Although not identified in any of the archaeological test pits, it was thought that this layer might rise eastward, and might contain small vertebrate, molluscan and ostracod evidence, in light of its olive colour, which suggested calcareous preservation conditions.

Progressing eastward, the base of the gravels was not reached in any of test pits 4, 5, 6 or 7, which ranged in basal depth from 32 m OD (test pit 4) to 34 m OD (test pit 7). Chalk bedrock was reached at the base of test pits 8 and 9, rising eastward from *c.*34 m OD in test pit 8 to 35 m OD in test pit 9. Finally, the base of the gravels rose more sharply to *c.*37.5 m OD in test pit 10, where it overlay a layer *c.*50 cm thick of Thanet Sand, separated from the underlying Chalk by flints of the Bullhead Bed.

In all eight test pits the Boyn Hill sands and gravels were overlain by humic sandy gravel topsoil (Group iv).

Deposits	*Group /phase*	*Period*
Topsoil	iv	Present
Dartford Heath (≈ Boyn Hill/Orsett Heath) Gravel - fluvial sands and gravels	iii	Pleistocene
Thanet Sands	ii	Tertiary
Chalk	i	Cretaceous

Table 2. *Stratigraphic summary (field evaluation)*

2.3.2 Archaeological sampling and finds

Details of the numbers of samples sieved and the finds are given below (Table 3). In total, 3,900 litres of gravel were sieved. Just one possible Palaeolithic flint artefact was found in the Boyn Hill Gravel. It was found in the trench 7 test pit in a layer of sandy gravel (context 707) 3.5 m below the ground surface (at *c.*35.3 m OD). It was small, technologically undiagnostic and in a moderately rolled condition. There is a more than 50:50 chance that it is natural, considering it is from a deposit that reflects high energy fluvial deposition, which would inevitably have involved the natural creation of many small flint flakes by the knocking together of larger pieces of flint.

Test pit	*Context*	*Sample/s*	*Vol. sieved (lit.)*	*Artefacts/faunal remains*
3	302	3.1	100	-
		3.2	100	-
	303	3.3	100	-
		3.4	100	-
		3.5	100	-
		3.6	100	-
	306	3.7	100	-
4	402	4.1	100	-
	403	4.2	100	-
		4.3	100	-
	404	4.4	100	-
	407	4.5	100	-
5	503	5.1	100	-
		5.2	100	-
	504	5.3	100	-
	505	5.4	100	-
	506	5.5	100	-
6	603	6.1	100	-
		6.2	100	-
		6.3	100	-
	605	6.4	100	-
		6.5	100	-
	606	6.6	100	-
7	703	7.1	100	-
		7.2	100	-
	705	7.3	100	-
	707	7.4	100	-

		7.5	100	Flint flake (??) — probably of natural origin
	709	7.6	100	-
8	803	8.1	100	-
		8.2	100	-
	805	8.3	100	-
		8.4	100	-
9	904	9.1	100	-
		9.2	100	-
		9.3	100	-
		9.4	100	-
10	1003	10.1	100	-
	1005	10.2	100	-

Table 3. *Sieve sampling of gravels (field evaluation)*

2.3.3 Biological/palaeo-environmental evidence

No biological palaeo-environmental evidence was found in any of eight Section C test pits, nor any sediments potentially suitable for the presence of such evidence, though a potentially rewarding sandy clay was identified in borehole BH8.

2.4 Evaluation conclusions

The significance and potential for analysis of the deposits are summarised below (Table 4). Although only one dubious flint artefact was found, the presence of Pleistocene fluvial deposits in itself merited further investigation for artefacts and faunal remains. Establishing the absence of artefacts in such sediments is as worthy a goal for Palaeolithic research as collecting a larger sample of whatever artefacts may be present. Considering the level of debate over the mapped Boyn Hill deposits in this area, and in particular over how many — one or two — terraces are represented, it was important that the long section resulting from the impact of the Fastrack scheme was fully recorded by means of monitoring of construction works. Furthermore the chances of identifying a part of the deposits with biological/palaeo-environmental evidence were much greater if a large exposure was seen, although as it turned out, none was found.

Nature of evidence present	*Palaeolithic significance*	*Research framework objectives*	*Priorities for investigation*
● Pleistocene fluvial sediments, probably including limited horizons of fine-grained channel-fill deposits ● possible Palaeolithic flint debitage	Medium-high	● Develop regional/national framework of cultural change ● Dating artefact-bearing deposits within regional, national and international Quaternary frameworks ● Patterns of colonisation, settlement and abandonment through the Pleistocene ● Developing a regional framework of Pleistocene landscape history	● Larger-scale sampling/monitoring for artefacts and faunal remains ● Full recording of cross-section through Pleistocene sequence ● Monitoring for fine-grained calcareous horizons with biological/palaeo-environmental evidence

Table 4. *Significance, potential and priorities for Palaeolithic investigation*

3 MITIGATING FIELDWORK

3.1 Aims and objectives

Following the conclusions of the field evaluation, the overall goals of the mitigating work were to contribute to:

- Development of the regional/national framework of cultural change during the Palaeolithic
- Dating artefact-bearing deposits within regional, national and international Quaternary frameworks
- Identifying patterns of human colonisation, settlement and abandonment through the Pleistocene
- Developing a regional framework of Pleistocene landscape history.

More specifically, the work aimed to:

- Identify whether there is evidence in the long exposure through the deposits created by the works that can resolve the debate over whether the Dartford deposits contain one, or two, major phases of deposition
- Record and date the major deposits exposed
- Identify the context, presence, prevalence and nature of any artefactual or large mammalian remains
- Identify/sample any sediments with other biological palaeo-environmental remains
- Establish correlations of any Pleistocene deposits found with reference to adjacent and regional sequences, and to national frameworks

3.2 Methods

The archaeological mitigation comprised the following work elements:

- Section cleaning/recording
- Sieving for artefacts/faunal remains
- General monitoring of groundworks that impact upon Pleistocene sediments

No suitable sediments for dating by optically stimulated luminescence (OSL) were present. Nor was any suitable material for sampling for vertebrate remains or other bio-environmental material encountered. As Dartford Heath Gravel, with which the gravels here are correlated (see below), has been sampled for clast lithological analysis at Wansunt Pit, Bexley Hospital and Miskin Road, Dartford (*c*.5 km, 4 km and 1.5 km, respectively, to the west), further sampling was not considered necessary.

3.2.1 Section cleaning and recording

The investigated area extended approximately 450 m, from site marker 1750 m westwards to marker 1300 m, on the south side of the cutting, which sloped at approximately 30º (Plate 1). Sections were cleaned by spade, hoe and trowel as appropriate from the top of the slope at 15 points as indicated below and in Figures 6 and 7. The Sections were up to 2.0 m wide and extended up to 6 m down the slope, their locations and heights OD being identified by surveying. As the Sections were at the same angle as the slope, it should be noted that sediment thicknesses are not true thicknesses, though because the drawings were controlled by surveying, the altitudinal positions of the sediments are correct.

The positions of the Sections were as follows

Site metre mark	**Section number**
1750 (east)	19
1700	5
1690	6
1660	7
1630	8
1600	9
1570	10
1540	11
1500	12
1470	13
1430	14
1410	15
1380	16
1350	17
1330 (west)	18

3.2.2 Sieving for artefacts

Bulk samples for sieving for artefacts and faunal remains were retrieved during the groundworks. Twelve sieving locations (SL 1–12) were selected along the Princes road cutting at roughly 50 m intervals (Fig. 6, 7). The location of each was recorded with reference to the site chainage, and all bar one of the sieving locations coincided with cleaned sections (cf. Table 5). At each of the sieving locations it was attempted to take samples of 1 cubic metre of gravel for every 1m depth of gravel present. This proved difficult in view of: the limited working space (beside the main A225 into Dartford); the need for samples to be loaded into a dumper truck and moved off-site; the working method of the machine that was cutting the full length of the face in one scoop; and the unwillingness of the groundworks contractors to interrupt or delay their convoy of larger trucks shifting spoil off site to allow taking of controlled archaeological samples. Nonetheless, a reasonable quantity of samples was taken with adequate stratigraphic control, and it was possible to take a vertical stack of more than one sample at over half the sieving locations (Table 5).

The samples were sieved through a 12 mm mesh for artefacts and faunal remains. Although most samples comprised 1 m^3 as intended, some of them were a bit less due to difficulties in getting a full sample from a controlled vertical horizon, and it was decided to focus on getting smaller samples with better stratigraphic control. In total 16,615 litres of gravel were sieved — an unprecedentedly large volume for the Dartford Heath Gravel.

Sieving location (SL)	*Section*	*Chainage*	*Samples*	*Depth below GS (m)*	*Volume (lit.)*	*Artefacts*
12	19	1760	12.1	0–0.5	1000	-
1	5	1710	1.1 1.2	1.00–1.20 1.50–2.00	1000 1000	-
2	6	1690	2.1	1.00–1.25	1000	-
3	7	1660–	3.1	1.00–1.50	1000	-

		1665	3.2	1.50–2.20	1000	
4	9	1600	4.1 4.2	0.25–0.75 1.00–1.75	1000 525	-
5	10	1570	5.1 5.2	1.00–1.50 1.75–2.50	1000 1000	-
9	-	1510	9.1 9.2 9.3	0.50–1.25 1.50–2.00 2.50–3.00	480 270 500	-
10	13	1470	10.1 10.2	0.50–1.00 1.00–1.75	525 315	-
8	14	1430	8.1	0.50–1.25	1000	-
7	16	1380	7.1	0.50–1.00	1000	-
6	17	1350	6.1 6.2	0.50–1.00 1.00–1.50	1000 1000	-
11	18	1330	11.1	0.50–1.25	1000	One fresh condition flint flake

Table 5. *Bulk sample sieving (mitigation)*

3.2.3 General monitoring of groundworks that impact upon Pleistocene sediments

Besides the survey-controlled section drawings (Fig. 8), important boundaries were traced by clearing with a hoe or trowel between the Sections 12 and 18 and located by tapes.

4 STRATIGRAPHY

From the section exposed it was possible to record the distribution and nature of the Pleistocene sediments and establish a local Pleistocene stratigraphy (Table 6).

Age	*Sediment type*	*Maximum thickness (m)*	*Environment*	*Stratigraphy*
Modern	Soil and made ground	0.23		
Pleistocene	Sandy gravel and sand	1.0	Colluvial	Head
	Sandy gravel with sand lenses	5.0	Braided river	Dartford Heath Gravel ≈Orsett Heath Gravel ≈Boyn Hill Terrace
	Silty sand	2.0	Disturbed	Thanet Sand
	Rounded and nodular flint	0.25	Disturbed	Bullhead Bed
	Sub-angular to Sub-rounded chalk in fine chalk matrix	Due to deformation thickness not obtained	Periglacial mudflow	Coombe rock
	Brecciated chalk	"	Periglacial shattering	
Cretaceous	In situ chalk			Upper Chalk

Table 6. *Stratigraphy, Princes Road, Section C*

4.1 Chalk/brecciated chalk/coombe rock

In situ Chalk was not seen in any of the cleaned Sections but was present in the lower parts of the cutting and flooring the Fastrack road formation.

In the Sections the Chalk was seen either to be broken into angular blocks, which still fitted together, where it had been shattered (brecciated) or to be in the form of relatively small (up to 5 cm) sub-angular or sub-rounded clasts in a matrix of fine chalk, forming coombe rock. Both the brecciated chalk and the coombe rock were seen to be displaced, often at high angles, e.g. Sections 16 and 18.

The brecciation of the Chalk and the formation of the coombe rock indicate breakdown of the Chalk by frost-shattering and its subsequent movement downslope as mudflow in periglacial conditions. The displacement of these beds is discussed below.

4.2 Bullhead Bed (displaced)

The Bullhead Bed is frequently present at the junction of the Chalk/coombe rock and the overlying Thanet Sand and forms the basal element of that Sand. The Bed comprises large flints, some rounded, some nodular as they would have been in the Chalk. Often they have characteristic brown discolouration beneath their cortex, due to weathering. The Bed represents a residual cover of flint left as the Chalk was eroded and they represent a long hiatus from 83 million years ago (end-Santonian, Late Cretaceous) to 58 million years ago (beginning of the Thanetian, Palaeocene). Its frequent presence at the junction is significant as it indicates that although the Chalk is much disturbed, its movement has been limited and has not been sufficient to disperse the Bullhead flints.

4.3 Thanet Sands (displaced)

The Thanet Sand comprises silty-clayey fine-grained sand. When fresh the Sand usually has a greenish-grey colour due to the presence of glauconite, which because it contains iron, causes the Sand to turn yellow when weathered. Hence the upper part of the Sand is often yellow. None of the Thanet Sand was deemed to be in situ but was severely affected by the disturbances to the Chalk mentioned above. In Section 13 small-scale faults formed a criss-cross pattern (conjugate faulting) (Fig. 8A).

4.4 Dartford Heath Gravel

When in situ, the gravel comprises horizontally-bedded sandy gravel with frequent sand lenses (Plate 2). The sand is usually medium- to coarse-grained and the gravel is mostly less than 5 cm in diameter, comprising predominantly rounded to sub-angular flint, with lesser amounts of rounded vein quartz and small amounts of brown and grey quartzite and other lithologies.

Between metre marks 1750 and 1470, only the upper part of Dartford Heath Gravel was exposed and was in situ, but between 1630 and 1330, the lower part was seen and was deformed, particularly westwards of 1500 m (Fig. 7).

The frequency of the test pits and the sections and the ability to trace the deposit between the sections show the gravel to be a single, continuous unit within an altitudinal range of 32 to 40 m OD. The test pits extended further east than the sections and showed the base of the Dartford Heath Gravel to rise (test pits C8, 9, 10) causing the Gravels to thin. As these pits are near the southern limit of the Dartford Heath Gravel (mapped as Boyn Hill Gravel), the rise of the base and the thinning are likely to be associated with local strand (shoreline) of the palaeo-Thames.

The altitudinal range compares well with Section 2 at Dartford Heath, Wansunt Pit (4 km to the west; TQ 513737), Section 2, where a continuous exposure of gravel occurs between 31 and 38 m OD) (White *et al*., 1995), and a direct correlation is made. The sedimentology of the Gravel is also in keeping with the Orsett Heath Gravel. As there is debate about the relationship of the Dartford Heath Gravel and the Orsett Heath/Boyn Hill Gravel, correlation of the gravel at Prince's Road with the Dartford Heath Gravel on the basis of the close altitudinal relationship reduces the ambiguity.

The relationship of the Gravel with the exposures of the Orsett Heath/Boyn Hill Member of the Swanscombe area (4 km to the east) is less clear. Although the Member has a height range there from 22 m OD (base of Lower Gravel/Lower Loam channel at Barnfield Pit) to 39 m OD (top of Upper Loam at Sweyne County Primary School — Wenban-Smith and Bridgland, 2001), the sequence is more complex and fluvial gravels appear to occupy only a lower position within that complex, below 29 m OD. Further investigation of the geomorphological situation in the Swanscombe area may help resolve the sedimentological differences.

4. 5 Colluvial sand and gravel

Between metre marks 1750 and 1430 (Sections 19, 5–14), the Dartford Heath Gravel was succeeded by a further gravel which was more poorly sorted and set in a matrix with a high silt and clay content, making it dusty when dry, and was usually a red-brown colour. The flints were often more bleached and more angular. The bed overlay the Dartford Heath Gravel discordantly and in places channelled into it, in a minor fashion.

The nature of the matrix, the bleached flints and the discordant relationship to the underlying gravels indicate that this is a separate deposit, a slopewash (colluvium) formed by reworking of the Dartford Heath Gravel.

4.6 Deformational structures

The deformation structures could be divided into four groups.

<u>Solution hole subsidence.</u> The area is known for the frequency of solution hollows in the Chalk; many are shown on the local geological map (British Geological Survey, 1:50,000 Sheet 271, Dartford). Within the face of the cutting, the Dartford Heath Gravel and the Thanet Sand frequently descend to great depths, as at metre marks 1490, 1460-1450, 1370, 1360, 1340 and 1330, suggesting the presence of solution hollows. A smaller example, or perhaps the edge of a larger feature, may occur in Section 16 (Fig. 8B).

<u>Load structures.</u> In saturated conditions, the silty-clayey nature of the Thanet Sand and the coombe rock would make them unable to support the weight of the overlying Dartford Heath Gravel. In periglacial conditions, the ground can become super-saturated due to the hygroscopic nature of the ice during the freezing process. During the frozen phase this is of no consequence, but in the thawing phase, the super-saturated ground has very little bearing strength. In such conditions, the Gravel would tend to sink into the underlying beds (loading) and in response, the displaced beds would inject upwards (diapiring). The sinking gravel would tend to form rounded concave structures, with the beds deformed and attenuated but not necessarily disrupted, as in Sections 14, 15, 16 and 18. In contrast, diapir structures usually form tight convex or inverted 'V' shapes, as in Sections 15, where the Thanet Sand has injected upwards, with the Dartford Heath Gravel sinking to form gentler concavities either side (Fig. 8C), and 18, where the Chalk (coombe rock) has diapired and deflected to the west and the Thanet Sand and Dartford Heath Gravel have sunk to form a complex concave structure (Fig. 8D). In both cases the Bullhead Bed has retained its integrity despite the deformation.

<u>Valley bulging.</u> The base of the Dartford Heath Gravel, best seen in Sections 10 to 13, is irregular and lies between 32 and 33 m OD. West of these Sections, the Gravel becomes thinner and the base becomes highly irregular, reaching 35 to 36 m OD, in and between

Sections 14 to 17 (Plate 3), before falling back to 34 m OD in Section 18 (Fig. 7). This appears to be a case of valley bulging, another phenomenon associated with periglacial supersaturation. Towards the valley side, as the ground surface declines, the Dartford Heath Gravel becomes thinner and so imposes a lesser load on the underlying mobile Thanet Sand and coombe rock. Consequently the higher loads imposed by the thicker Gravel away from the valley side are relieved by upwelling of the Thanet Sand and coombe rock under the thinner valley side gravel.

Faulting. Minor faults were observed in Sections 13 and 16 (Fig 8A, 8B). In Section 13, the faulting occurred with the Thanet Sand in the form of a criss-cross pattern (conjugate faulting), which implies application of vertical pressure. Inspection of the Section and its immediate surrounding indicates that the Dartford Heath Gravel had subsided into the Thanet Sand. This is likely to have been the cause of the vertical stress. In Section 16, there was a normal fault, downthrowing 0.5 m to the east. Such faulting is likely to be associated with collapse of sediments into a solution hollow. The downward extension of the Thanet Sand in the basal part of the Section, may be part of the solution hollow.

5 ARTEFACT SIEVING AND RECOVERY

Despite the large volume of gravel sieved (20.5 m^3, combining the evaluation with the mitigation) only one undisputable flint artefact was found, as well as two possible ones (Table 7).

Test-pit/ Sieving location/ Section	*Context*	*Sediment description*	*Depth*	*Artefact*
Test pit 7 (evaluation)	707	Horizontally bedded Dartford Heath Gravel	35.5 m OD, *c.*3.5 m below ground surface	Small rolled flint flake (probably of natural origin)
Section 14	1405	Gravel-filled solution pipe	35.2 m OD, *c.*1 m below ground surface	△1 — Small rolled flint flake (possibly of natural origin)
Sieving location 11 (section 18)	1807	Gravel-filled solution pipe	32 m OD, *c.*1 m below ground surface	△2 — Medium-size flint waste flake, fresh condition

Table 7. *Lithic artefacts*

The undoubted flake (△2) was a medium-sized waste flake. It was unpatinated and in fresh condition, but technologically undiagnostic. It had a wide striking platform with a clear point of percussion, and the dorsal surface was mostly cortical, with one large scar from a previous removal crossing the distal end.

It was found in the bulk sample from sieving location 11 (at section 18), at the extreme western end of the cutting (Fig. 7). There is a high likelihood that the artefact is a Holocene intrusion. Some dark grayish-brown loam similar to the local topsoil was adhering to the artefact, and the top of the sample was right underneath the base of the topsoil. Even if genuinely from the gravel at this location, there is a question-mark over whether the artefact originates from the main body of Dartford Heath Gravel being investigated. The gravel at the location is (a) very convoluted, appearing to represent a pipe filling a solution pocket between *c.*31 and 29 m OD and (b) is divided from the main body of Dartford Heath Gravel further to the east by the chalky ridge of the valley bulge. Thus, even if from the gravel-filled solution pipe, it could represent a reworked intrusion from a later phase than the main Dartford Heath Gravel.

The possible flint artefact (△1) from section 14 was found during section cleaning, so its provenance is indisputable. However, it also comes from a gravel-filled solution pipe, and is thus not from the main *in situ* Dartford Heath Gravel. It is very abraded and light grey patinated. It has a tiny striking platform and point of percussion, and numerous small dorsal scars. On balance, this piece is probably a genuine artefacts, although could possible have been formed by natural depositional processes. As for flake △2, it does not originate from the main Dartford Heath Gravel body exposed in the main cutting.

6 DISCUSSION AND CONCLUSIONS

6.1 Stratigraphic correlation and dating

The Chalk is of Santonian age from the Mesozoic era, deposited between 85 and 83 million years ago (Gradstein and Ogg, 1996), though different authorities give slightly different ages. The Bullhead Bed and the Thanet Sands are of Thanetian age within the Palaeocene, deposited between 58 and 57 million years ago (Ellison *et al*., 2004), again different authorities giving slightly different dates. The displacement of these beds occurred during the Pleistocene and the dating of this is discussed below.

The test pit and section cleaning investigations proved that the major Pleistocene deposit, the sandy gravel, was part the body of the Dartford Heath Gravel, on the basis of altitudinal range and sedimentology, and that only one gravel body was present. The close similarity of the altitudinal ranges correlates the gravels here closely with the outcrop at the Wansunt Pit, Dartford Heath. This clarifies correlation of the Gravel in the Dartford area and so makes a positive contribution to the local stratigraphy. However, correlation with the outcrop at Swanscombe is more difficult and resolution of the relationship of the Dartford Heath Gravel to the Orsett Heath/Boyn Hill Gravel requires further investigation.

The Dartford Heath/Orsett Heath/Boyn Hill Gravel has been dated on the basis of altitude, floral and faunal evidence to a time span from late MIS 12 (the Anglian cold stage) through MIS 11 (the Hoxnian temperate stage) to early MIS 10 (an un-named cold stage) (Bridgland, 1994; Wenban-Smith and Bridgland, 2001). The evidence found in this investigation does not resolve the long-standing controversy over whether more than one phase of deposition is represented in the mapped Dartford Heath Gravel. Consequently we cannot date the gravel seen more precisely than the range MIS 12–10.

The substantial thickness of the gravel (which perhaps indicates a late glacial or early post-glacial date - cf. Section 6.2), together with the lack of artefacts, possibly provides some support to the idea that the gravel body pre-dates the Barnfield Pit sequence, where artefacts are abundant from the base of the Lower Gravel upwards.

6.1.2 Dating of deformations

Dating the formation of the brecciated chalk and the coombe rock is more difficult as appropriate evidence was not available in the Sections. These sediments are overlain by the Dartford Heath Gravel and so, by the laws of super-position, should be older. They were not observed in Sections 19 and 5 to 10 where the Dartford Heath Gravel is thicker and undisturbed. If they are present there, then a pre-Dartford Heath Gravel age is implied. However, they are best developed in Sections 12-18, where the cover of the Gravel is thin or absent, so the periglacial freezing processes necessary for their formation could have operated through the thin cover. For reasons outlined below, it is thought this was most likely to have occurred late in the Pleistocene (Late Devensian (MIS 2) or the Loch Lomond Stadial).

Solution holes. Unfortunately the solution hollows are recognised principally from their overall shape, by the deep penetrations of Thanet Sand into the Chalk, as at 1450, 1370, 1360 and 1340 m. Confirming evidence such as faulting and collapse structures occur only in Section 16. However, the solution hollows appear to have been functioning while the Thanet Sand was being deposited as it infills the penetrations. For the most part, the Dartford Heath Gravel does not appear to be involved in the penetrations, suggesting the solution holes were mostly no longer functioning at the time of its deposition. Only at 1490 and 1400 m does the Gravel appear to be involved in the penetrations, but only on a small-scale.

Loading structures. These structures involve both the Thanet Sand and the Dartford Heath Gravel and so post-date the deposition of the Gravel. The structures are best developed where the valley bulge is evident, from Section 12 to 18, suggesting an association. Given the stresses and instability associated with bulging, such loading adjustments are quite likely to occur. Indeed, the valley bulge can be considered a large-scale loading structure in its own right. Smaller scale disturbances can be seen affecting the basal parts of the Dartford Heath Gravel in Sections 8, 10-13, presumably marginal loading adjustments associated with the bulging.

Valley bulging. The valley bulge would have occurred after the River Darent had incised below the level of the Dartford Heath Gravel. Following Bridgland (2004), the Darent would have first incised to below the level of the Dartford Heath Gravel late in cold stage MIS 10. Thus, thus the valley bulging and loading could have occurred in any cold stage from MIS 10 onwards (MIS 10, 8, 6, 2). However, as the features relate to the present landscape, they are most likely to have formed in the late in the Pleistocene (MIS 2 or even a later short cold spell known as the Loch Lomond Stadial).

Faulting. The two examples are very small-scale and are minor features related to the development of the solution hollows and loading structures/valley bulging.

6.2 Site formation and palaeo-environment

The main body of Dartford Heath Gravel represents high energy fluvial deposition, with occasional episodes of lower energy flow represented by the thin sand beds sometimes seen. The substantial body of gravel probably represents deposition late in the Anglian glaciation, or early in the warming phase of the Hoxnian interglacial.

The outcomes from the study of the brecciated chalk, coombe rock and the various displacement and deformation structures have been particularly illuminating for the neotectonic (recent deformational) history of the area.

Solution holes have been recorded from several local quarries and many are noted on the local geological map (British Geological Survey, 1:50,000 Sheet 271).

The **load structures** are of more interest. Their mode of formation is similar to that of periglacial involutions, which are common phenomena in local quarries. However, they differ from these in that they are more complex in their geometry and, because they involve the Thanet Sand and Dartford Heath Gravel, are more complex in their sedimentology. Thus this investigation has advanced our understanding of these structures.

Valley bulging has not been reported from the local area before, so this record makes a novel and significant contribution to the local Pleistocene geology.

6.3 The lack of human artefactual evidence

The overall conclusion of the archaeological investigation is that the main Dartford Heath Gravel is lacking in lithic artefacts at this location. This is a potentially significant finding, since the east end of the cutting is within 50 m of the channel bank, and flint nodules would have been locally abundant, either from the Chalk or the Bullhead Bed which both would have been locally exposed. Consequently, if there had been hominid presence in the region at the time of the gravel deposition, one would expect this to be reflected in a reasonably abundant artefactual presence at this location.

7 ARCHIVE

The site archive will be lodged with an appropriate Museum in due course. Finds and the paper archive are held at Oxford Archaeology, Janaus House, Osney Mead, Oxford OX2 OES

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DARTFORD FASTRACK (SECTION C): PALAEOLITHIC/PLEISTOCENE INVESTIGATIONS

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SUMMARY

Archaeological and geological field investigations of Section C of the Dartford Fastrack Scheme have confirmed certain aspects of the local geology and have brought to light periglacial structures not previously recorded. The investigations confirmed the local occurrence of the Dartford Heath Gravel (≈ Orsett Heath Gravel, ≈ Boyn Hill Gravel) and enabled its relationship to the gravels on Dartford Heath and at Swanscombe to be examined. Periglacial load structures of more complexity than the local involutions have been described and valley bulging is reported for the first time.

No unequivocal Palaeolithic artefacts were found, despite sieving of very large quantities of gravel. This suggests that there was no human presence in the area at the time of this deposit's formation, which perhaps implies it was not laid down at the same time as any part of the Boyn Hill Gravel sequence at Swanscombe, which is rich throughout in Palaeolithic remains.

1 INTRODUCTION

1.1 Project background

Archaeological field investigations were required by Kent County Council in advance of construction works for the Kent Thameside Fastrack scheme at Dartford (Fig. 1). Pleistocene fluvial deposits are mapped in the area of Princes Road to the A282 Junction 1B (Section C), so Palaeolithic/Pleistocene investigations were carried out along this part of the route. This archive report covers the results of both initial field evaluation and also subsequent mitigating work.

1.2 Site location and topography

The Fastrack scheme runs south from central Dartford, down the east side of the Darent Valley and then east, crossing the M25 and passing Darent Valley Hospital before descending into Bluewater shopping centre. Section C of the scheme runs east–west along Princes Road for *c.*500 m, between Darenth Road and the A282/M25 (Junction 1B), in the form of a cutting widening the existing Princes Road carriageway to the south (Fig. 2). The ground surface (at the top of the cutting) along this stretch descends westward from *c.*40 m OD to *c.*25 m OD. The base of the cutting descends from *c.*40 m OD to *c.*23 m OD, with a maximum depth of almost 10 m in the central part.

1.3 Palaeolithic and geological background

The evaluation area is located in the southern part of an area of Pleistocene deposits mapped as Boyn Hill Gravel that underlies much of Dartford. These deposits are part of a more widespread formation that is preserved on the south side of the Lower Thames in an intermittently occurring east–west trending band from Dartford Heath through Dartford centre, Stone and Greenhithe to Swanscombe and ultimately Northfleet. The deposits in the formation consist of predominantly fluviatile loam, sand and gravel units laid down by the ancient Thames. There is currently great debate over the age of these deposits, and over whether the thick deposits in the Dartford area contain a single group of deposits (Bridgland 1994) or two superimposed groups (Gibbard 1994).

According to Bridgland, the Dartford deposits represent a single major terrace aggradation dating from the end of the Anglian glaciation and the early part of the Hoxnian interglacial period between 450,000 and 350,000 BP (late marine isotope stage [MIS] 12 to early MIS 10), and are directly equivalent to the Boyn Hill/Orsett Heath deposits at Barnfield Pit, Swanscombe, *c.*5 km to the east. According to Gibbard, the thick sequence at Dartford includes two groups of deposits: an older and higher late Anglian Dartford Heath Gravel, which correlates with the Middle Thames Black Park Gravel; and a slightly lower and younger terminal Anglian and early Hoxnian member, which correlates with the Boyn Hill/Orsett Heath deposits at Swanscombe.

The Pleistocene fluvial deposits preserved between Dartford Heath and Northfleet are rich in significant Palaeolithic archaeological remains. Quarrying activity at numerous locations has produced flint artefacts, faunal remains and other biological evidence relating to climate and environment (Wymer 1968 & 1999; Roe 1981). The best-investigated sites are in the Boyn Hill/Orsett Heath deposits at Greenhithe and Swanscombe, *c.*5 km to the east, but numerous stray finds of handaxes, flakes and faunal remains have also been made in the more westerly patches of gravel towards Dartford Heath. Three find-spots of handaxes are known from the gravel deposits immediately north of Princes Road (Wessex Archaeology 1993), and one of the old quarries in this vicinity is also reported to have produced molluscan and large mammalian faunal remains (Newton 1895: 521).

Generally, the Dartford area is rich in Palaeolithic sites, and Section C of the Fastrack scheme impacted upon a Pleistocene deposit with high potential to contain Palaeolithic remains or other evidence that could help place known local sites in a better context of understanding. Consequently the archaeological programme for this section incorporated Palaeolithic/Pleistocene investigations.

1.4 Fieldwork events

The Palaeolithic/Pleistocene investigations comprised (i) an initial phase of field evaluation, followed by (ii) further investigations and recording during the construction programme (Table 1).

Event	*Scope*	*Summary details*	*Date*
DAFT04	Field evaluation	A row of deep test pits along cutting route, with sieving of spit samples for artefacts	9–12 August 2004
DAFT 04 (WB1)	Mitigating investigations during construction	Recording of sequence exposed in cutting, and sieving of bulk samples for artefacts	22 October to 1 December 2004

Table 1. *Palaeolithic/Pleistocene fieldwork events*

2 FIELD EVALUATION

2.1 Aims and objectives

The overall goals of the field evaluation were:

- To assess the nature and significance of the Pleistocene deposits and Palaeolithic remains present
- To establish the distribution and depth across the site of the Pleistocene deposits
- To assess the Palaeolithic archaeological significance of any deposits

More specifically, the work also aimed to:

- Determine the presence and potential of lithic artefact evidence and faunal remains in the sediments encountered
- Determine the presence and potential of palaeo-environmental micro-biological evidence in the sediments encountered
- Determine the presence of, or potential for, undisturbed primary context Palaeolithic occupation surfaces in the sediments encountered
- Establish the horizontal and vertical extent, sequence and sedimentological character of Pleistocene deposits across the site
- Interpret the depositional and post-depositional history of any artefactual or biological evidence found

- Establish correlations of any Pleistocene deposits found with reference to adjacent and regional sequences, and to national frameworks

- Assess in local, regional and national terms, the archaeological and geological significance of any Pleistocene deposits encountered, and their potential to fulfil current research objectives

2.2 Methods

Eight deep test pits were excavated at one end of evaluation trenches 3 to 10 (Fig. 3). The topsoil of each trench was removed over an area of 20m by 2m using a 2m wide trenching bucket down to the top of the underlying Pleistocene sediments, in most cases to a depth of approximately 0.3m. The exposed deposits were then investigated for archaeological features and deposits. Deeper test pits were then excavated at one end of each evaluation trench in order to investigate the underlying Pleistocene deposits. All test pits were of the order of 4–5m in length and initially 2m in width, dug using the trenching bucket. Below safe working depth a toothed bucket of approximately 1.2m in width was used to excavate down to Chalk bedrock, or as far as it was possible to go. The deposits were observed and recorded and a series of 100 litre samples taken and sieved through a 10mm mesh, and sorted for artefacts.

2.3 Results

2.3.1 Stratigraphy

Four major groups of deposit (i–iv) were present, although not in all test pits, corresponding to major phases of deposition (Table 2). Detailed records of the stratigraphy and attribution of sediment units to depositional groups are given for each test pit (Appendix 1). In summary, Pleistocene deposits associated with the Boyn Hill/Orsett Heath Member were present in all the test pits, thickening and deepening to the west (Fig. 4, Fig. 5 - section details). At the west end of the site (Trench 3), the base of the Boyn Hill deposits was not reached (at a depth of 32 m OD). Geotechnical borehole BH 8, *c.*200m further to the west, also failed to reach the base of the Boyn Hill deposits (at a depth of 24.3 m OD).

Interestingly, the bottom 2.5m of this borehole comprised soft orange-brown sandy clay with some fine–medium flint gravel, rather than typical loose sandy Boyn Hill gravel — the base of which occurred at 26.9 m OD. This borehole also contained a horizon *c.*1m thick of olive sandy clay between *c.*30m and 31 m OD. Although not identified in any of the archaeological test pits, it was thought that this layer might rise eastward, and might contain small vertebrate, molluscan and ostracod evidence, in light of its olive colour, which suggested calcareous preservation conditions.

Progressing eastward, the base of the gravels was not reached in any of test pits 4, 5, 6 or 7, which ranged in basal depth from 32 m OD (test pit 4) to 34 m OD (test pit 7). Chalk bedrock was reached at the base of test pits 8 and 9, rising eastward from *c.*34 m OD in test pit 8 to 35 m OD in test pit 9. Finally, the base of the gravels rose more sharply to *c.*37.5 m OD in test pit 10, where it overlay a layer *c.*50 cm thick of Thanet Sand, separated from the underlying Chalk by flints of the Bullhead Bed.

In all eight test pits the Boyn Hill sands and gravels were overlain by humic sandy gravel topsoil (Group iv).

Deposits	*Group /phase*	*Period*
Topsoil	iv	Present
Dartford Heath (≈ Boyn Hill/Orsett Heath) Gravel - fluvial sands and gravels	iii	Pleistocene
Thanet Sands	ii	Tertiary
Chalk	i	Cretaceous

Table 2. *Stratigraphic summary (field evaluation)*

2.3.2 Archaeological sampling and finds

Details of the numbers of samples sieved and the finds are given below (Table 3). In total, 3,900 litres of gravel were sieved. Just one possible Palaeolithic flint artefact was found in the Boyn Hill Gravel. It was found in the trench 7 test pit in a layer of sandy gravel (context 707) 3.5 m below the ground surface (at *c.*35.3 m OD). It was small, technologically undiagnostic and in a moderately rolled condition. There is a more than 50:50 chance that it is natural, considering it is from a deposit that reflects high energy fluvial deposition, which would inevitably have involved the natural creation of many small flint flakes by the knocking together of larger pieces of flint.

Test pit	*Context*	*Sample/s*	*Vol. sieved (lit.)*	*Artefacts/faunal remains*
3	302	3.1	100	-
		3.2	100	-
	303	3.3	100	-
		3.4	100	-
		3.5	100	-
		3.6	100	-
	306	3.7	100	-
4	402	4.1	100	-
	403	4.2	100	-
		4.3	100	-
	404	4.4	100	-
	407	4.5	100	-
5	503	5.1	100	-
		5.2	100	-
	504	5.3	100	-
	505	5.4	100	-
	506	5.5	100	-
6	603	6.1	100	-
		6.2	100	-
		6.3	100	-
	605	6.4	100	-
		6.5	100	-
	606	6.6	100	-
7	703	7.1	100	-
		7.2	100	-
	705	7.3	100	-
	707	7.4	100	-

		7.5	100	Flint flake (??) — probably of natural origin
	709	7.6	100	-
8	803	8.1	100	-
		8.2	100	-
	805	8.3	100	-
		8.4	100	-
9	904	9.1	100	-
		9.2	100	-
		9.3	100	-
		9.4	100	-
10	1003	10.1	100	-
	1005	10.2	100	-

Table 3. *Sieve sampling of gravels (field evaluation)*

2.3.3 Biological/palaeo-environmental evidence

No biological palaeo-environmental evidence was found in any of eight Section C test pits, nor any sediments potentially suitable for the presence of such evidence, though a potentially rewarding sandy clay was identified in borehole BH8.

2.4 Evaluation conclusions

The significance and potential for analysis of the deposits are summarised below (Table 4). Although only one dubious flint artefact was found, the presence of Pleistocene fluvial deposits in itself merited further investigation for artefacts and faunal remains. Establishing the absence of artefacts in such sediments is as worthy a goal for Palaeolithic research as collecting a larger sample of whatever artefacts may be present. Considering the level of debate over the mapped Boyn Hill deposits in this area, and in particular over how many — one or two — terraces are represented, it was important that the long section resulting from the impact of the Fastrack scheme was fully recorded by means of monitoring of construction works. Furthermore the chances of identifying a part of the deposits with biological/palaeo-environmental evidence were much greater if a large exposure was seen, although as it turned out, none was found.

Nature of evidence present	*Palaeolithic significance*	*Research framework objectives*	*Priorities for investigation*
● Pleistocene fluvial sediments, probably including limited horizons of fine-grained channel-fill deposits ● possible Palaeolithic flint debitage	Medium-high	● Develop regional/national framework of cultural change ● Dating artefact-bearing deposits within regional, national and international Quaternary frameworks ● Patterns of colonisation, settlement and abandonment through the Pleistocene ● Developing a regional framework of Pleistocene landscape history	● Larger-scale sampling/monitoring for artefacts and faunal remains ● Full recording of cross-section through Pleistocene sequence ● Monitoring for fine-grained calcareous horizons with biological/palaeo-environmental evidence

Table 4. *Significance, potential and priorities for Palaeolithic investigation*

3 MITIGATING FIELDWORK

3.1 Aims and objectives

Following the conclusions of the field evaluation, the overall goals of the mitigating work were to contribute to:

- Development of the regional/national framework of cultural change during the Palaeolithic
- Dating artefact-bearing deposits within regional, national and international Quaternary frameworks
- Identifying patterns of human colonisation, settlement and abandonment through the Pleistocene
- Developing a regional framework of Pleistocene landscape history.

More specifically, the work aimed to:

- Identify whether there is evidence in the long exposure through the deposits created by the works that can resolve the debate over whether the Dartford deposits contain one, or two, major phases of deposition
- Record and date the major deposits exposed
- Identify the context, presence, prevalence and nature of any artefactual or large mammalian remains
- Identify/sample any sediments with other biological palaeo-environmental remains
- Establish correlations of any Pleistocene deposits found with reference to adjacent and regional sequences, and to national frameworks

3.2 Methods

The archaeological mitigation comprised the following work elements:

- Section cleaning/recording
- Sieving for artefacts/faunal remains
- General monitoring of groundworks that impact upon Pleistocene sediments

No suitable sediments for dating by optically stimulated luminescence (OSL) were present. Nor was any suitable material for sampling for vertebrate remains or other bio-environmental material encountered. As Dartford Heath Gravel, with which the gravels here are correlated (see below), has been sampled for clast lithological analysis at Wansunt Pit, Bexley Hospital and Miskin Road, Dartford (*c*.5 km, 4 km and 1.5 km, respectively, to the west), further sampling was not considered necessary.

3.2.1 Section cleaning and recording

The investigated area extended approximately 450 m, from site marker 1750 m westwards to marker 1300 m, on the south side of the cutting, which sloped at approximately 30º (Plate 1). Sections were cleaned by spade, hoe and trowel as appropriate from the top of the slope at 15 points as indicated below and in Figures 6 and 7. The Sections were up to 2.0 m wide and extended up to 6 m down the slope, their locations and heights OD being identified by surveying. As the Sections were at the same angle as the slope, it should be noted that sediment thicknesses are not true thicknesses, though because the drawings were controlled by surveying, the altitudinal positions of the sediments are correct.

The positions of the Sections were as follows

Site metre mark	**Section number**
1750 (east)	19
1700	5
1690	6
1660	7
1630	8
1600	9
1570	10
1540	11
1500	12
1470	13
1430	14
1410	15
1380	16
1350	17
1330 (west)	18

3.2.2 Sieving for artefacts

Bulk samples for sieving for artefacts and faunal remains were retrieved during the groundworks. Twelve sieving locations (SL 1–12) were selected along the Princes road cutting at roughly 50 m intervals (Fig. 6, 7). The location of each was recorded with reference to the site chainage, and all bar one of the sieving locations coincided with cleaned sections (cf. Table 5). At each of the sieving locations it was attempted to take samples of 1 cubic metre of gravel for every 1m depth of gravel present. This proved difficult in view of: the limited working space (beside the main A225 into Dartford); the need for samples to be loaded into a dumper truck and moved off-site; the working method of the machine that was cutting the full length of the face in one scoop; and the unwillingness of the groundworks contractors to interrupt or delay their convoy of larger trucks shifting spoil off site to allow taking of controlled archaeological samples. Nonetheless, a reasonable quantity of samples was taken with adequate stratigraphic control, and it was possible to take a vertical stack of more than one sample at over half the sieving locations (Table 5).

The samples were sieved through a 12 mm mesh for artefacts and faunal remains. Although most samples comprised 1 m^3 as intended, some of them were a bit less due to difficulties in getting a full sample from a controlled vertical horizon, and it was decided to focus on getting smaller samples with better stratigraphic control. In total 16,615 litres of gravel were sieved — an unprecedentedly large volume for the Dartford Heath Gravel.

Sieving location (SL)	*Section*	*Chainage*	*Samples*	*Depth below GS (m)*	*Volume (lit.)*	*Artefacts*
12	19	1760	12.1	0–0.5	1000	-
1	5	1710	1.1 1.2	1.00–1.20 1.50–2.00	1000 1000	-
2	6	1690	2.1	1.00–1.25	1000	-
3	7	1660–	3.1	1.00–1.50	1000	-

		1665	3.2	1.50–2.20	1000	
4	9	1600	4.1 4.2	0.25–0.75 1.00–1.75	1000 525	-
5	10	1570	5.1 5.2	1.00–1.50 1.75–2.50	1000 1000	-
9	-	1510	9.1 9.2 9.3	0.50–1.25 1.50–2.00 2.50–3.00	480 270 500	-
10	13	1470	10.1 10.2	0.50–1.00 1.00–1.75	525 315	-
8	14	1430	8.1	0.50–1.25	1000	-
7	16	1380	7.1	0.50–1.00	1000	-
6	17	1350	6.1 6.2	0.50–1.00 1.00–1.50	1000 1000	-
11	18	1330	11.1	0.50–1.25	1000	One fresh condition flint flake

Table 5. *Bulk sample sieving (mitigation)*

3.2.3 General monitoring of groundworks that impact upon Pleistocene sediments

Besides the survey-controlled section drawings (Fig. 8), important boundaries were traced by clearing with a hoe or trowel between the Sections 12 and 18 and located by tapes.

4 STRATIGRAPHY

From the section exposed it was possible to record the distribution and nature of the Pleistocene sediments and establish a local Pleistocene stratigraphy (Table 6).

Age	*Sediment type*	*Maximum thickness (m)*	*Environment*	*Stratigraphy*
Modern	Soil and made ground	0.23		
Pleistocene	Sandy gravel and sand	1.0	Colluvial	Head
	Sandy gravel with sand lenses	5.0	Braided river	Dartford Heath Gravel ≈Orsett Heath Gravel ≈Boyn Hill Terrace
	Silty sand	2.0	Disturbed	Thanet Sand
	Rounded and nodular flint	0.25	Disturbed	Bullhead Bed
	Sub-angular to Sub-rounded chalk in fine chalk matrix	Due to deformation thickness not obtained	Periglacial mudflow	Coombe rock
	Brecciated chalk	"	Periglacial shattering	
Cretaceous	In situ chalk			Upper Chalk

Table 6. *Stratigraphy, Princes Road, Section C*

4.1 Chalk/brecciated chalk/coombe rock

In situ Chalk was not seen in any of the cleaned Sections but was present in the lower parts of the cutting and flooring the Fastrack road formation.

In the Sections the Chalk was seen either to be broken into angular blocks, which still fitted together, where it had been shattered (brecciated) or to be in the form of relatively small (up to 5 cm) sub-angular or sub-rounded clasts in a matrix of fine chalk, forming coombe rock. Both the brecciated chalk and the coombe rock were seen to be displaced, often at high angles, e.g. Sections 16 and 18.

The brecciation of the Chalk and the formation of the coombe rock indicate breakdown of the Chalk by frost-shattering and its subsequent movement downslope as mudflow in periglacial conditions. The displacement of these beds is discussed below.

4.2 Bullhead Bed (displaced)

The Bullhead Bed is frequently present at the junction of the Chalk/coombe rock and the overlying Thanet Sand and forms the basal element of that Sand. The Bed comprises large flints, some rounded, some nodular as they would have been in the Chalk. Often they have characteristic brown discolouration beneath their cortex, due to weathering. The Bed represents a residual cover of flint left as the Chalk was eroded and they represent a long hiatus from 83 million years ago (end-Santonian, Late Cretaceous) to 58 million years ago (beginning of the Thanetian, Palaeocene). Its frequent presence at the junction is significant as it indicates that although the Chalk is much disturbed, its movement has been limited and has not been sufficient to disperse the Bullhead flints.

4.3 Thanet Sands (displaced)

The Thanet Sand comprises silty-clayey fine-grained sand. When fresh the Sand usually has a greenish-grey colour due to the presence of glauconite, which because it contains iron, causes the Sand to turn yellow when weathered. Hence the upper part of the Sand is often yellow. None of the Thanet Sand was deemed to be in situ but was severely affected by the disturbances to the Chalk mentioned above. In Section 13 small-scale faults formed a criss-cross pattern (conjugate faulting) (Fig. 8A).

4.4 Dartford Heath Gravel

When in situ, the gravel comprises horizontally-bedded sandy gravel with frequent sand lenses (Plate 2). The sand is usually medium- to coarse-grained and the gravel is mostly less than 5 cm in diameter, comprising predominantly rounded to sub-angular flint, with lesser amounts of rounded vein quartz and small amounts of brown and grey quartzite and other lithologies.

Between metre marks 1750 and 1470, only the upper part of Dartford Heath Gravel was exposed and was in situ, but between 1630 and 1330, the lower part was seen and was deformed, particularly westwards of 1500 m (Fig. 7).

The frequency of the test pits and the sections and the ability to trace the deposit between the sections show the gravel to be a single, continuous unit within an altitudinal range of 32 to 40 m OD. The test pits extended further east than the sections and showed the base of the Dartford Heath Gravel to rise (test pits C8, 9, 10) causing the Gravels to thin. As these pits are near the southern limit of the Dartford Heath Gravel (mapped as Boyn Hill Gravel), the rise of the base and the thinning are likely to be associated with local strand (shoreline) of the palaeo-Thames.

The altitudinal range compares well with Section 2 at Dartford Heath, Wansunt Pit (4 km to the west; TQ 513737), Section 2, where a continuous exposure of gravel occurs between 31 and 38 m OD) (White *et al*., 1995), and a direct correlation is made. The sedimentology of the Gravel is also in keeping with the Orsett Heath Gravel. As there is debate about the relationship of the Dartford Heath Gravel and the Orsett Heath/Boyn Hill Gravel, correlation of the gravel at Prince's Road with the Dartford Heath Gravel on the basis of the close altitudinal relationship reduces the ambiguity.

The relationship of the Gravel with the exposures of the Orsett Heath/Boyn Hill Member of the Swanscombe area (4 km to the east) is less clear. Although the Member has a height range there from 22 m OD (base of Lower Gravel/Lower Loam channel at Barnfield Pit) to 39 m OD (top of Upper Loam at Sweyne County Primary School — Wenban-Smith and Bridgland, 2001), the sequence is more complex and fluvial gravels appear to occupy only a lower position within that complex, below 29 m OD. Further investigation of the geomorphological situation in the Swanscombe area may help resolve the sedimentological differences.

4. 5 Colluvial sand and gravel

Between metre marks 1750 and 1430 (Sections 19, 5–14), the Dartford Heath Gravel was succeeded by a further gravel which was more poorly sorted and set in a matrix with a high silt and clay content, making it dusty when dry, and was usually a red-brown colour. The flints were often more bleached and more angular. The bed overlay the Dartford Heath Gravel discordantly and in places channelled into it, in a minor fashion.

The nature of the matrix, the bleached flints and the discordant relationship to the underlying gravels indicate that this is a separate deposit, a slopewash (colluvium) formed by reworking of the Dartford Heath Gravel.

4.6 Deformational structures

The deformation structures could be divided into four groups.

<u>Solution hole subsidence.</u> The area is known for the frequency of solution hollows in the Chalk; many are shown on the local geological map (British Geological Survey, 1:50,000 Sheet 271, Dartford). Within the face of the cutting, the Dartford Heath Gravel and the Thanet Sand frequently descend to great depths, as at metre marks 1490, 1460-1450, 1370, 1360, 1340 and 1330, suggesting the presence of solution hollows. A smaller example, or perhaps the edge of a larger feature, may occur in Section 16 (Fig. 8B).

<u>Load structures.</u> In saturated conditions, the silty-clayey nature of the Thanet Sand and the coombe rock would make them unable to support the weight of the overlying Dartford Heath Gravel. In periglacial conditions, the ground can become super-saturated due to the hygroscopic nature of the ice during the freezing process. During the frozen phase this is of no consequence, but in the thawing phase, the super-saturated ground has very little bearing strength. In such conditions, the Gravel would tend to sink into the underlying beds (loading) and in response, the displaced beds would inject upwards (diapiring). The sinking gravel would tend to form rounded concave structures, with the beds deformed and attenuated but not necessarily disrupted, as in Sections 14, 15, 16 and 18. In contrast, diapir structures usually form tight convex or inverted 'V' shapes, as in Sections 15, where the Thanet Sand has injected upwards, with the Dartford Heath Gravel sinking to form gentler concavities either side (Fig. 8C), and 18, where the Chalk (coombe rock) has diapired and deflected to the west and the Thanet Sand and Dartford Heath Gravel have sunk to form a complex concave structure (Fig. 8D). In both cases the Bullhead Bed has retained its integrity despite the deformation.

<u>Valley bulging.</u> The base of the Dartford Heath Gravel, best seen in Sections 10 to 13, is irregular and lies between 32 and 33 m OD. West of these Sections, the Gravel becomes thinner and the base becomes highly irregular, reaching 35 to 36 m OD, in and between

Sections 14 to 17 (Plate 3), before falling back to 34 m OD in Section 18 (Fig. 7). This appears to be a case of valley bulging, another phenomenon associated with periglacial supersaturation. Towards the valley side, as the ground surface declines, the Dartford Heath Gravel becomes thinner and so imposes a lesser load on the underlying mobile Thanet Sand and coombe rock. Consequently the higher loads imposed by the thicker Gravel away from the valley side are relieved by upwelling of the Thanet Sand and coombe rock under the thinner valley side gravel.

<u>Faulting.</u> Minor faults were observed in Sections 13 and 16 (Fig 8A, 8B). In Section 13, the faulting occurred with the Thanet Sand in the form of a criss-cross pattern (conjugate faulting), which implies application of vertical pressure. Inspection of the Section and its immediate surrounding indicates that the Dartford Heath Gravel had subsided into the Thanet Sand. This is likely to have been the cause of the vertical stress. In Section 16, there was a normal fault, downthrowing 0.5 m to the east. Such faulting is likely to be associated with collapse of sediments into a solution hollow. The downward extension of the Thanet Sand in the basal part of the Section, may be part of the solution hollow.

5 ARTEFACT SIEVING AND RECOVERY

Despite the large volume of gravel sieved (20.5 m^3, combining the evaluation with the mitigation) only one undisputable flint artefact was found, as well as two possible ones (Table 7).

Test-pit/ Sieving location/ Section	*Context*	*Sediment description*	*Depth*	*Artefact*
Test pit 7 (evaluation)	707	Horizontally bedded Dartford Heath Gravel	35.5 m OD, *c.*3.5 m below ground surface	Small rolled flint flake (probably of natural origin)
Section 14	1405	Gravel-filled solution pipe	35.2 m OD, *c.*1 m below ground surface	△1 — Small rolled flint flake (possibly of natural origin)
Sieving location 11 (section 18)	1807	Gravel-filled solution pipe	32 m OD, *c.*1 m below ground surface	△2 — Medium-size flint waste flake, fresh condition

Table 7. *Lithic artefacts*

The undoubted flake (△2) was a medium-sized waste flake. It was unpatinated and in fresh condition, but technologically undiagnostic. It had a wide striking platform with a clear point of percussion, and the dorsal surface was mostly cortical, with one large scar from a previous removal crossing the distal end.

It was found in the bulk sample from sieving location 11 (at section 18), at the extreme western end of the cutting (Fig. 7). There is a high likelihood that the artefact is a Holocene intrusion. Some dark grayish-brown loam similar to the local topsoil was adhering to the artefact, and the top of the sample was right underneath the base of the topsoil. Even if genuinely from the gravel at this location, there is a question-mark over whether the artefact originates from the main body of Dartford Heath Gravel being investigated. The gravel at the location is (a) very convoluted, appearing to represent a pipe filling a solution pocket between *c.*31 and 29 m OD and (b) is divided from the main body of Dartford Heath Gravel further to the east by the chalky ridge of the valley bulge. Thus, even if from the gravel-filled solution pipe, it could represent a reworked intrusion from a later phase than the main Dartford Heath Gravel.

The possible flint artefact (△1) from section 14 was found during section cleaning, so its provenance is indisputable. However, it also comes from a gravel-filled solution pipe, and is thus not from the main *in situ* Dartford Heath Gravel. It is very abraded and light grey patinated. It has a tiny striking platform and point of percussion, and numerous small dorsal scars. On balance, this piece is probably a genuine artefacts, although could possible have been formed by natural depositional processes. As for flake △2, it does not originate from the main Dartford Heath Gravel body exposed in the main cutting.

6 DISCUSSION AND CONCLUSIONS

6.1 Stratigraphic correlation and dating

The Chalk is of Santonian age from the Mesozoic era, deposited between 85 and 83 million years ago (Gradstein and Ogg, 1996), though different authorities give slightly different ages. The Bullhead Bed and the Thanet Sands are of Thanetian age within the Palaeocene, deposited between 58 and 57 million years ago (Ellison *et al*., 2004), again different authorities giving slightly different dates. The displacement of these beds occurred during the Pleistocene and the dating of this is discussed below.

The test pit and section cleaning investigations proved that the major Pleistocene deposit, the sandy gravel, was part the body of the Dartford Heath Gravel, on the basis of altitudinal range and sedimentology, and that only one gravel body was present. The close similarity of the altitudinal ranges correlates the gravels here closely with the outcrop at the Wansunt Pit, Dartford Heath. This clarifies correlation of the Gravel in the Dartford area and so makes a positive contribution to the local stratigraphy. However, correlation with the outcrop at Swanscombe is more difficult and resolution of the relationship of the Dartford Heath Gravel to the Orsett Heath/Boyn Hill Gravel requires further investigation.

The Dartford Heath/Orsett Heath/Boyn Hill Gravel has been dated on the basis of altitude, floral and faunal evidence to a time span from late MIS 12 (the Anglian cold stage) through MIS 11 (the Hoxnian temperate stage) to early MIS 10 (an un-named cold stage) (Bridgland, 1994; Wenban-Smith and Bridgland, 2001). The evidence found in this investigation does not resolve the long-standing controversy over whether more than one phase of deposition is represented in the mapped Dartford Heath Gravel. Consequently we cannot date the gravel seen more precisely than the range MIS 12–10.

The substantial thickness of the gravel (which perhaps indicates a late glacial or early post-glacial date - cf. Section 6.2), together with the lack of artefacts, possibly provides some support to the idea that the gravel body pre-dates the Barnfield Pit sequence, where artefacts are abundant from the base of the Lower Gravel upwards.

6.1.2 Dating of deformations

Dating the formation of the brecciated chalk and the coombe rock is more difficult as appropriate evidence was not available in the Sections. These sediments are overlain by the Dartford Heath Gravel and so, by the laws of super-position, should be older. They were not observed in Sections 19 and 5 to 10 where the Dartford Heath Gravel is thicker and undisturbed. If they are present there, then a pre-Dartford Heath Gravel age is implied. However, they are best developed in Sections 12-18, where the cover of the Gravel is thin or absent, so the periglacial freezing processes necessary for their formation could have operated through the thin cover. For reasons outlined below, it is thought this was most likely to have occurred late in the Pleistocene (Late Devensian (MIS 2) or the Loch Lomond Stadial).

<u>Solution holes.</u> Unfortunately the solution hollows are recognised principally from their overall shape, by the deep penetrations of Thanet Sand into the Chalk, as at 1450, 1370, 1360

and 1340 m. Confirming evidence such as faulting and collapse structures occur only in Section 16. However, the solution hollows appear to have been functioning while the Thanet Sand was being deposited as it infills the penetrations. For the most part, the Dartford Heath Gravel does not appear to be involved in the penetrations, suggesting the solution holes were mostly no longer functioning at the time of its deposition. Only at 1490 and 1400 m does the Gravel appear to be involved in the penetrations, but only on a small-scale.

Loading structures. These structures involve both the Thanet Sand and the Dartford Heath Gravel and so post-date the deposition of the Gravel. The structures are best developed where the valley bulge is evident, from Section 12 to 18, suggesting an association. Given the stresses and instability associated with bulging, such loading adjustments are quite likely to occur. Indeed, the valley bulge can be considered a large-scale loading structure in its own right. Smaller scale disturbances can be seen affecting the basal parts of the Dartford Heath Gravel in Sections 8, 10-13, presumably marginal loading adjustments associated with the bulging.

Valley bulging. The valley bulge would have occurred after the River Darent had incised below the level of the Dartford Heath Gravel. Following Bridgland (2004), the Darent would have first incised to below the level of the Dartford Heath Gravel late in cold stage MIS 10. Thus, thus the valley bulging and loading could have occurred in any cold stage from MIS 10 onwards (MIS 10, 8, 6, 2). However, as the features relate to the present landscape, they are most likely to have formed in the late in the Pleistocene (MIS 2 or even a later short cold spell known as the Loch Lomond Stadial).

Faulting. The two examples are very small-scale and are minor features related to the development of the solution hollows and loading structures/valley bulging.

6.2 Site formation and palaeo-environment

The main body of Dartford Heath Gravel represents high energy fluvial deposition, with occasional episodes of lower energy flow represented by the thin sand beds sometimes seen. The substantial body of gravel probably represents deposition late in the Anglian glaciation, or early in the warming phase of the Hoxnian interglacial.

The outcomes from the study of the brecciated chalk, coombe rock and the various displacement and deformation structures have been particularly illuminating for the neotectonic (recent deformational) history of the area.

Solution holes have been recorded from several local quarries and many are noted on the local geological map (British Geological Survey, 1:50,000 Sheet 271).

The **load structures** are of more interest. Their mode of formation is similar to that of periglacial involutions, which are common phenomena in local quarries. However, they differ from these in that they are more complex in their geometry and, because they involve the Thanet Sand and Dartford Heath Gravel, are more complex in their sedimentology. Thus this investigation has advanced our understanding of these structures.

Valley bulging has not been reported from the local area before, so this record makes a novel and significant contribution to the local Pleistocene geology.

6.3 The lack of human artefactual evidence

The overall conclusion of the archaeological investigation is that the main Dartford Heath Gravel is lacking in lithic artefacts at this location. This is a potentially significant finding, since the east end of the cutting is within 50 m of the channel bank, and flint nodules would have been locally abundant, either from the Chalk or the Bullhead Bed which both would have been locally exposed. Consequently, if there had been hominid presence in the region at the time of the gravel deposition, one would expect this to be reflected in a reasonably abundant artefactual presence at this location.

7 ARCHIVE

The site archive will be lodged with an appropriate Museum in due course. Finds and the paper archive are held at Oxford Archaeology, Janaus House, Osney Mead, Oxford OX2 OES

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APPENDIX 1. TEST PIT LOGS (FIELD EVALUATION)

Trench 3 test pit

TOP-SOIL

301 TOPSOIL. Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w–rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

302 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular).

303 SANDY GRAVEL. Medium. orange brown m–c sandy gravel, m. compacted to firm and matrix supported (just); common poor to m. well sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with common (f–m, light yellowish brown, sub-ang to angular) and occ (m–c, light yellowish brown, sub-ang to angular) clasts below 1,6m

304 SANDY GRAVEL. Medium orange brown m–c sandy gravel, m. compacted to firm and matrix supported (just); common m. well sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with rare (f–m, light yellowish brown, sub-ang to angular) flints

305 SAND. Medium yellowish brown m. sand, only present in Eastern end of TP

306 SANDY GRAVEL. Medium orange brown m–c sandy gravel, m. compacted to firm and matrix supported (just); common m. well sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with occ. (f–m, light yellowish brown, sub-ang to angular) flints and rare (c, light yellowish brown sub-angular to angular) flints

307 SANDY GRAVEL. Medium yellowish brown f. sandy gravel, m. compacted and matrix supported; m. common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) with occ. (f, light yellowish brown, sub-ang to angular) flints

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
302	3.1	100	-	-
302	3.2	100	-	-
303	3.3	100	-	-
303	3.4	100	-	-
303	3.5	100	-	-
303	3.6	100	-	-
306	3.7	100	-	-

Trench 4 test pit

N-facing

m OD

TOP-SOIL

401 TOPSOIL. Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w–rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

402 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints.

403 SANDY GRAVEL. Medium orange brown m–c sandy gravel, m. compacted to firm and matrix supported (just); common poor to mod well sorted Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–c, light yellowish brown, sub-ang to angular). Course peb's most common between 0,6m and 1,5m, becoming rare below 2,2m. Note: Probable periglacial feature in Eastern end of TP of approx 2m in depth. Filled with same material as context 402 but with additional frost shattered m-c. flints

404 SAND. Medium yellowish brown f–m sand with v. rare fine mostly black w. rounded flints.

405 SANDY GRAVEL. Medium orange brown m. sandy gravel, m. compacted to firm and matrix supported (just); common poor to m. well sorted Tertiary flints (f–m, black, w–rounded) with common larger (f–c, light yellowish brown, sub-ang to angular) flints

406 SAND. Medium yellowish brown m. sand, no flints

407 SANDY GRAVEL. Poorly sorted m. sandy gravel, m. compacted and matrix supported (just); common Tertiary flints (f–m, black, w–rounded) with common larger (m, light yellowish brown, sub-ang to angular) flints

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
402	4.1	100	-	-
403	4.2	100	-	-
403	4.3	100	-	-
404	4.4	100	-	-
407	4.5	100	-	-

Trench 5 test pit

N-facing
m OD

TOP-SOIL

501 TOPSOIL. Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w-rounded) and occasional flint peb’s (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

502 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

503 SANDY GRAVEL. Medium orange brown m–c sandy gravel, loose to m. loose and matrix supported; common poorly sorted (particularly above 1m) Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–c, light yellowish brown, sub-ang to angular) flints. Coarse peb’s become rare below 2m. Note: Possible periglacial feature along Western edge of test pit, approx. 3,1m deep from top of context 503. Fill consists of f-m. silty sand and rare fine w-rounded black flints. Fill is very different from feature in TP 3.

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
503	5.1	100	-	-
503	5.2	100	-	-
503	5.3	100	-	-
503	5.4	100	-	-
503	5.5	100	-	-

Trench 6 test pit

N-facing
m OD

TOP-SOIL

601 Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w-rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

602 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

603 SANDY GRAVEL. Medium orange brown m. sandy gravel, m-f compact and matrix supported, becoming firmer and more compact below 1,5m, more compact than other trenches; common poorly sorted (particularly above 1m) Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–c, light yellowish brown, sub-ang to angular) and rare (c, light yellowish brown, sub-ang to angular) peb's, particularly below 1,5m.

604 SAND. Medium yellowish brown m. sand with v. rare v. small rounded Tertiary and angular to sub-angular flints

605 SANDY GRAVEL. Medium orange brown m. sandy gravel, m–f compact and matrix supported, common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–c, light yellowish brown, sub-ang to angular) flints

606 SANDY GRAVEL. Light to medium yellowish brown m. sandy gravel, matrix supported and m. loose; rare poorly sorted fine sub-angular to angular flints

607 SANDY GRAVEL. Medium orange brown m. sandy gravel, m. compact and matrix supported; common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–m, light yellowish brown, sub-ang to angular) flints

608 SANDY GRAVEL. Medium yellowish brown m-c sandy gravel; common poorly sorted Tertiary flints (f, black, w–rounded); common shell fragments (reworked marine) mostly <2mm with rare pieces <8mm

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
603	6.1	100	-	-
603	6.2	100	-	-
603	6.3	100	-	-
605	6.4	100	-	-
605	6.5	100	-	-
606	6.6	100	-	-
608	-	-	-	Reworked Tertiary shells

Trench 7 test pit

N-facing

m OD

TOP-SOIL

701 TOP SOIL. Mid to dark greyish brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w–rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

702 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

703 SANDY GRAVEL. Medium orange brown m-c. sandy gravel, m. compact and clast supported for upper 0,35m, becoming more sandy and matrix supported below 1m; common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) with common larger (f–m, light yellowish brown, sub-ang to angular) down to 1,2m, and rare (c, light yellowish brown, sub-ang to angular) peb's, particularly below 1,5m. Note: Possible periglacial feature in East end of TP filled with gravel similar to that from context 702

704 SAND. Medium orange to yellowish brown medium sand with rare Tertiary flints (m, black, w–rounded)

705 SANDY GRAVEL. Medium orange brown m-c. sandy gravel, m. compact and matrix supported; common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) and common poorly sorted (f, light yellowish brown, sub-ang to angular) flints

706 SAND. Medium orange to yellowish brown f-m sand with occ. small (<2cm) clay pockets

707 SANDY GRAVEL. Medium orange brown m. sandy gravel, m. compact and matrix supported; common poorly sorted Tertiary flint clasts (mostly f, black, w–rounded) and occ. poorly sorted (f–m, light yellowish brown, sub-ang to angular) flints; black stained gravel (f–m, w–rounded) at 3,40m to 3,45m

708 SAND. Medium yellowish brown m. sand

709 SANDY GRAVEL. Medium yellowish brown m-c sandy gravel, loose matrix supported; common poorly sorted Tertiary flints (f, black, w–rounded) and rare (m–c, light yellowish brown sub-angular) flints

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
703	7.1	100	-	-
703	7.2	100	-	-
705	7.3	100	-	-
707	7.4	100	-	-
707	7.5	100	Poss. flint flake (Pal.)	-
709	7.6	100	-	-

Trench 8 test pit

N-facing

m OD

TOP-SOIL

801 Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w-rounded) and occ. flint peb's (m, light yellow brown, sub-ang); m. loose and friable, roots

PLEISTOCENE FLUVIAL SANDS & GRAVELS

802 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

803 SANDY GRAVEL. Medium orange brown m–c sandy gravel, mod. compact becoming less compact below 1m; common poorly sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with common (m, light yellowish brown, sub-ang to angular) and v rare (m–c, light yellowish brown, sub-ang to angular) flints

804 SAND. Light to medium orange brown mod compact medium sand with occ. poorly sorted Tertiary flints (f, black, w–rounded); occ. small (<2cm) clay pockets

805 SANDY GRAVEL. Medium yellowish brown m–c sandy gravel, mod. compact to firm; common poorly sorted Tertiary flint clasts (mostly f–m, black, w–rounded), and common (m, light yellowish brown, sub-ang to angular) becoming more common below 2.4m and rare (m–c, light yellowish brown, sub-ang to angular) flints

806 SAND. Light to medium yellowish brown m. sand, mod loose with v. rare Tertiary flints (f, black, w–rounded)

807 SANDY GRAVEL. Medium yellowish brown m-c sandy gravel, loose matrix supported; v. common poorly sorted Tertiary flints (f–m, black, w–rounded), v. common small re-deposited Tertiary shell fragments mostly <2mm

808 SAND. Medium greyish brown mod. compacted well bedded m. sand; v. rare Tertiary flints (f, black, w–rounded)

809 SANDY GRAVEL & CHALK. Medium yellowish brown m–c sandy gravel, loose and matrix supported; v. common poorly sorted Tertiary flints (f–m, black, w–rounded), common (c, fresh, sub-ang to angular) flint nodules and large chalk blocks up to 15cm,), v. common small re-deposited Tertiary shell fragments mostly <2mm

CHALK BEDROCK (DEGRADED SURFACE)

810 CHALK. Chalk bedrock

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
803	8.1	100	-	-
803	8.2	100	-	-
805	8.3	100	-	-
805	8.4	100	-	-

Trench 9 test pit

N-facing
m OD

TOP-SOIL
901 Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w-rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS
902 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

903 SAND. Medium orange brown m-c sand becoming m. coarse, towards base at 0,85m, mod. compact to compact

904 SANDY GRAVEL. Medium orange brown m–c sandy gravel, mod. compact; common poorly sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with common (m, light yellowish brown, sub-ang to angular) and v. rare (m–c, light yellowish brown, sub-ang to angular) flints below 2m

905 SAND. Medium yellowish brown f–m sand, mod. compacted; common poorly sorted Tertiary flint clasts (f, black, w–rounded)

906 SANDY GRAVEL. Medium orange brown m–c sandy gravel, loose to mod. compact; common poorly sorted Tertiary flint clasts (mostly f–m, black, w–rounded) with common (m, light yellowish brown, sub-ang to angular)

907 SANDY GRAVEL. Medium yellowish brown m-c sandy gravel; common poorly sorted Tertiary flints (f, black, w–rounded); common shell fragments (reworked marine) mostly <2mm with rare pieces <8mm. Note: present only along Eastern edge of TP

908 SAND. Medium yellowish brown fine sand with rare Tertiary flints (f, black, w–rounded)

CHALK BEDROCK (DEGRADED SURFACE)
909 CHALK. Chalk bedrock

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
904	9.1	100	-	-
904	9.2	100	-	-
904	9.3	100	-	-
905	9.4	100	-	-

Trench 10 test pit

N-facing
m OD

TOP-SOIL

1001 TOPSOIL. Mid to dark greyish-brown fine silty sand with common Tertiary flint peb's (f–m, black, mostly w–rounded) and occasional flint peb's (m, light yellowish brown, sub-ang); moderately loose and friable; modern rooting

PLEISTOCENE FLUVIAL SANDS & GRAVELS

1002 GRAVEL. Poorly sorted loose f–m clast supported flint gravel in loose v. dry pale light to mid brown fine silty sand; clasts mostly Tertiary (mostly f, black, w–rounded) with occasional larger (f–m, light yellowish brown, sub-ang to angular) flints

1003 SANDY GRAVEL. Medium yellow grading to orange brown m. compact matrix supported f–m sandy gravel, v. common poorly sorted Tertiary flint clasts (f, black, w–rounded) with occ. (f, light yellowish brown, sub-ang to angular) flints

1004 SAND. Medium yellowish brown m sand with v. rare fine angular to sub–angular flints

1005 SANDY GRAVEL. Medium yellowish brown m. compact matrix supported f–m sandy gravel, v. common poorly sorted Tertiary flint clasts (f, black, w–rounded) with occ. (f, light yellowish brown, sub-ang to angular) flints

1006 REDEPOSITED THANET SAND & CHALK. Medium greyish green fine sand and f. chalk nodules

THANET SAND

1007 THANET SAND. Medium greyish green fine mod. loose friable sand; common stained bullhead flints (f–m, rounded to sub–angular) and rare larger (c.) sub–angular unstained flints with mottled grey matrix which become common towards base of sequence. Note: Chalk bedrock and Thanet Sands dip down dramatically towards the East at approx. 60 degrees at the Eastern end of the TP

CHALK BEDROCK

1008 CHALK. Chalk bedrock dipping slightly East to West by approx. 5 degrees and South to North by approx. 10 degrees

Archaeological sampling and finds

Context	*Samples*	*Vol. (lit.)*	*Lithic artefacts*	*Biological evidence*
1003	10.1	100	-	-
1005	10.2	100	-	-

APPENDIX 2. SECTION LOGS (MITIGATING RECORDING)

SECTION 5

Site metre position 1700 m

501 Very dark greenish/greyish/brown fine to medium **sand** with common medium to very coarse flint pebbles, generally sub-angular to angular, moderately soft subsoil, under stripped topsoil.

502 Loose, poorly sorted, coarse to very coarse flint **gravel**, in sand matrix (very fine to very coarse), almost clast-supported in places, moderately common small cobbles 8–12 cm, clasts often sub-angular to angular, occasionally very sharp frost-fractured edges; gen. yellowish brown.

503 Brownish-yellow, fine to medium **sand** with common medium to coarse flint pebbles (rounded to sub-angular, occasionally angular), moderately soft (very similar to 501 except for colour).

504 Moderately to well compacted, strong brown to yellowish red, medium to very coarse matrix-supported flint **gravel** moderately to poorly sorted, occasional small cobbles 6-8 cm; clasts sub-angular to rounded, occasionally angular; occ. frost-fractured angular pieces; matrix of sand/silt with vf–f gravel in places.

505 Brownish yellow/yellowish brown, fine to medium **sand** with moderately common medium to coarse flint pebbles, rounded to sub-angular.

506 Well compacted, moderately to poorly sorted, medium to coarse flint **gravel** with common small cobbles 8-15 cm, matrix-supported, coarse to very coarse clay-silty sand; general colour strong brown to yellowish red, smaller clasts generally rounded (Tertiary pebbles), cobbles generally sub-angular to angular.

SECTION 6

Site metre position 1690 m

601 See 501.

602 Dark yellowish brown, ?? silty fine to medium **sand** with common rounded to sub-angular medium to very coarse flints pebbles.

603 Loose, poorly sorted, very fine to very coarse flint **gravel**, clasts angular to rounded, generally yellowish brown.

604 Moderately to well compacted, moderately to poorly sorted, medium to very coarse flint **gravel** with common small cobbles 8-15 cm, generally sub-angular to angular, abraded and patinated flint nodules (or frost-fractured pieces of..) in variously silty or sandy matrix, clasts sub-angular to rounded, sometimes angular; gen. strong brown to yellowish red (= 506).

SECTION 7

Site metre position 1660 m

701 See 501/601

702 See 502/702

703 Moderately loose, poorly sorted, medium to very coarse, sub-angular to rounded **gravel** with frequent small cobbles 8-15 cm long with sub-angular, abraded/patinated flint nodules in medium to coarse sand with very fine gravel matrix.

704 Moderately compact, moderately to poorly sorted, medium to coarse flint **gravel** in strong brown/yellowish-red silty/sandy matrix; gravel clasts rounded to sub-angular, plus moderately common angular to sub-angular small cobbles.

705 Moderately loose, moderately sorted, medium to coarse flint **gravel** in yellowish brown, medium to very coarse sandy matrix.

706 Moderately loose, moderately to well sorted medium flint **gravel** in medium to very coarse sandy matrix with some very fine gravel; Mn-stained very dark red/purple.

707 Moderately compact, poorly sorted medium to very coarse flint gravel (with small cobbles) in medium to coarse yellowish brown sandy matrix.

708 Strong brown/yellowish red, medium to very coarse **sand** with 1-2 cm band of very fine gravel at base, moderately soft.

709 Wavy bedded, yellowish brown/brownish yellow fine to medium **sand**, moderately soft.

SECTION 8

Site metre position 1630 m

801 See 501 etc., subsoil under stripped topsoil.

802 Fine to medium, slightly silty **sand**, yellowish brown, moderately soft with occasional sub-angular to angular flint pebbles 2-6 cm, occasional small rounded flint, Tertiary pebbles <2 cm, occasional root intrusions.

803 Silty medium **sand/sandy silt**, moderately compacted, very occasional sub-angular to angular flint pebbles 2-6 cm, very occasional rounded black flint Tertiary pebbles <2 cm, very occasional root intrusions.

804 Coarse, moderately to poorly sorted, coarse to very coarse matrix-supported flint **gravel** (with moderately common small cobbles), strong brown to reddish yellow, generally moderately to well compacted, occasionally looser in patches; clasts angular to rounded, generally abraded; matrix is medium to very coarse sand and very fine gravel, silty in places, with occasional very coarse remnant bedding.

805 Silty medium **sand** grading from yellowish brown to brownish yellow, common flint pebbles, angular to sub-angular/sub-rounded, becoming less common to west

806 Medium coarse **sand**, brownish yellow with sub-horizontal reddish yellow staining, with lens of very fine to fine flint pebbles.

807 Moderately compacted, yellowish brown fine **sand/clayey-silt**, wavy sub-horizontal bedding c2-5 cm thick, generally slightly coarser towards top.

808 Brownish yellow, medium **sand**, wavy sub-horizontal bedding, 0.5-1 cm thick.

809 Loose, moderately to well sorted, yellowish brown, medium to coarse **gravel** in medium to very coarse sand matrix, clasts mostly rounded Tertiary pebbles, some sub-angular flint pebbles.

SECTION 9

Site metre position 1600 m

901 See 501 – subsoil.

902 Coarse, poorly sorted, yellow brown flint **gravel**, medium, yellowish brown flint gravel, loose, clast-supported, flint mostly Tertiary pebbles <6 cm, other clasts modal size very coarse and mostly angular, poorly sorted, matrix of coarse sand.

903 Coarse, moderately to poorly sorted, reddish brown **gravel**, strong brown to reddish yellow, moderately well compacted, variably clast- or matrix-supported, mostly small Tertiary pebbles <4 cm, other flints angular to sub-angular and generally abraded, moderately to poorly sorted, matrix of medium to coarse sand with occasional very coarse bedding structures.

904 Medium to coarse, yellow to reddish brown **sand**, occasional small Tertiary pebbles <1 cm, becomes more yellow towards base.

905 Coarse, moderately sorted, loose, reddish brown **gravel**, mostly small Tertiary pebbles <2 cm, but also common small <2 cm angular light greenish brown flints, occasional larger <10 cm angular flint nodules, non-Tertiary pebbles angular to sub-angular and generally abraded, matrix of coarse gritty sand.

906 Fine to medium light yellowish brown **sand** with very rare small <1 cm Tertiary pebbles, more orange at top, moderately firm with rare sub-horizontal bedding.

907 Same as 903 although slightly stronger red.

908 Fine to medium, light yellowish brown **sand** with very rare small <2 cm Tertiary pebbles, moderately firm with rare sub-horizontal bedding 2-5 cm thick.

909 Fine to medium, light yellowish brown **sand** with very rare small <1 cm Tertiary pebbles, moderately firm to firm, with common sub-horizontal wavy bedding 0.5-1 cm thick, frequent root intrusion.

910 As for 909.

911 Very strong reddish brown, firm, clast-supported **gravel**, mostly small rounded Tertiary pebbles <1 cm, with very rare larger pebbles up to 15 cm, plus with rare sub-angular to angular non-Tertiary flint pebbles, 1–4 cm.

912 As for 909 but with occasional fine clay-rich laminae.

913 Gritty yellowish brown loose **gravel**, mostly Tertiary pebbles <2 cm. (= 809)

SECTION 10

Site metre position 1570 m

1001 Subsoil (= 501)

1002 Coarse, moderately to poorly sorted, loose, yellowish brown flint **grave**l

1003 Fine to medium **sand**, medium reddish brown, with sub-horizontal laminations 1-5 cm thick, pockets and lenses of small Tertiary pebbles <1 cm and rare larger non-Tertiary pebbles <5 cm, angular and lightly abraded.

1004 Coarse, moderately loose, reddish brown **gravel**, variably clast- or matrix-supported, flints mostly Tertiary pebbles <5 cm, occasional non-Tertiary flint some large >10 cm, sub-angular and lightly rolled, matrix of coarse sand and chips of non-Tertiary and Tertiary flint.

1005 Very coarse, moderately sorted reddish brown **gravel** , clast-supported, flints mostly Tertiary pebbles <2 cm and occasional non-Tertiary flints <10 cm, non-Tertiary flints sub-angular and moderately rolled, matrix of coarse chips of Tertiary and non-Tertiary flint, same general make up as 1004 although with slightly fewer larger flints and less matrix.

1006 Same as 1004.

1007 Fine, light yellowish brown **sand**; moderately loose with fine sub-horizontal laminations <1 cm thick; small Tertiary pebbles in lower 2 cm.

1008 Oval-shaped pocket of mottled light greyish brown to medium brown **silty sand**, rare Tertiary pebbles <1 cm in central position and occasional larger <6 cm non-Tertiary pebbles, sub-angular and moderately rolled, outer ring of reddish brown medium sand with occasional small <2 cm Tertiary pebbles and sub-angular moderately rolled non-Tertiary pebbles <6 cm.

1009 Poorly sorted, yellowish brown, moderately coarse **gravel**, variously clast- and matrix-supported, flints mostly Tertiary pebbles <6 cm but with occasional large non-Tertiary nodules <15 cm, non-Tertiary pebbles sub-angular and moderately to well rolled, matrix of coarse sand and chips of Tertiary and non-Tertiary flint.

1011 Light to medium, reddish brown, coarse, loose **gravel** with layers and pockets of small Tertiary pebbles and no sand, rest of body mostly Tertiary pebbles up to 4cm with rare non-Tertiary pebbles <10 cm, sub-angular and moderately to well rolled, matrix of medium sand.

SECTION 11

Site metre position 1540 m

1101 Subsoil (= 501)

1102 Coarse, moderate to poorly sorted, loose, yellowish brown flint **gravel**, flints predominantly Tertiary pebbles <4 cm, some sub-angular and angular non-Tertiary pebbles , <7 cm, sandy matrix

1103 Coarse, moderately sorted, moderately loose, reddish brown **gravel**, variably clast- and matrix-supported, flints mostly Tertiary pebbles <5 cm and occasional non-Tertiary flint, some up to 10 cm, sub-angular and lightly rolled, matrix of coarse sands and chips of Tertiary and non-Tertiary flint.

1104 Fine to medium, moderately firm, yellowish brown **sand**, sub-horizontal laminations of 1-2 cm, some ripples, much micro-scouring, rare clay laminations of <1 cm

1105 Coarse, moderately well sorted, moderately firm, medium to dark reddish brown **gravel**, clast-supported, flints mostly Tertiary pebbles <2 cm and occasional non-Tertiary pebbles <2 cm, non-Tertiaries sub-angular and moderately rolled, matrix of coarse sand

1106 Fine to medium, moderately firm, yellowish brown to reddish brown **sand**, distinctive horizontal to wavy laminations of <1 cm, laminations consist of dark reddish hard mineralised bands

1107 Medium, moderately loose, light yellowish brown **sand** with sub-horizontal laminations <1 cm, with frequent small <1 cm Tertiary pebbles, occasional pockets of dense Tertiary shell fragments and small Tertiary pebbles, sand also becomes coarser downwards

1108 Coarse, well sorted, moderately loose, medium to dark brown **gravel**, clast-supported, flints small <1 cm and equal quantities of Tertiary and non-Tertiary pebbles, non-Tertiary pebbles rounded to sub-angular and well rolled, minimal matrix but consists of medium to coarse sand

1109 Medium to coarse, loose, reddish brown **sand**, common Tertiary pebbles mostly <2 cm and occasional non-Tertiary pebbles <6 cm, non-Tertiary pebbles angular and much rolled

1110 As for 1105

1111 Fine to medium, moderately compact, yellowish brown **sand**, well defined wavy laminae, truncated by 1115

1112 Coarse, poorly sorted, loose, yellowish brown to reddish brown **gravel**, variable clast- and matrix-supported, occasional lenses of Tertiary pebbles without sand matrix, mostly Tertiary pebbles <4 cm but with frequent non-Tertiary pebbles, sub-angular to rounded and mostly rolled to well rolled, some non-Tertiary pebbles large, up to 20 cm

1113 Fine to medium, firm, yellowish to reddish brown **sand**, sub-horizontal laminations 2-5 cm thick, rare Tertiary pebbles <1 cm, frequent root intrusions in sandy layer

1114 Coarse, well sorted, very loose yellowish brown **sandy gravel**, matrix-supported, flints Tertiary pebbles mostly <2 cm, frequent non-Tertiary pebbles sub-angular to angular, light to moderate rolling, matrix of fine to medium sand, occasional large Tertiary pebbles <6 cm

1115 Fine to medium, moderately compact, yellowish brown **sand**, frequent Tertiary pebbles <2 cm and occasional non-Tertiary pebbles <1 cm, angular and moderately rolled

1116 **Chalk** bedrock

SECTION 12

Site metre position 1500 m

1201 Dark subsoil (= 501)

1202 Coarse, medium yellowish brown, angular frost-fractured **gravel** in dry dusty matrix

1203 Various **gravels**, moderately coarse to coarse, variably clast- and matrix-supported, firm to moderately loose, mainly Tertiary pebbles <6 cm but with frequent non-Tertiary pebbles, angular to sub-angular and much rolled (could not describe in detail due to state of surface)

1204 Medium, reddish brown **sand**, firm with sub-horizontal laminae, 2-5 cm and very rare small <1 cm Tertiary pebbles

1205 Fine, light brown to yellowish brown **sand** with rare horizontal and sub-horizontal mineralised laminae <1 cm, occasional sub-angular non-Tertiary flints <6 cm, moderately rolled, very rare small Tertiary pebbles <1 cm, firm

1206 Moderately well sorted, loose, yellowish brown g**ravels**, variably clast-and matrix-supported, flints mostly Tertiary pebbles <4 cm, with occasional large non-Tertiary pebbles <10 cm, sub-angular and moderately rolled, matrix of medium to coarse yellow sand

1207 Medium greenish brown **Thanet Sand**, firm with frequent horizontal and sub-horizontal mineral (red) laminations; these disappear approximately 20 cm above the Chalk, large blocks of flint (Bullhead Bed) at Chalk surface, one large nodule 45 cm long, also fewer laminations in upper 20 cm due to less oxidation

1208 Fine to medium, moderately well sorted, loose **gravel**, dark reddish brown, clast-supported flint, mostly Tertiary pebbles <2 cm, non-Tertiary pebbles sub-angular, well rolled, very little matrix, but of medium to coarse sand

1209 **Chalk** bedrock; flints above Chalk where no Thanet Sand [1207] are not stained, those below Thanet Sand are usually stained, but not always.

SECTION 13

Site metre position 1470 m

1301 Subsoil (= 501)

1302 Very coarse, angular **gravel** in a dusty dry loose matrix.

1303 Moderately coarse to coarse variable **gravel**, loose to moderately loose, yellowish to reddish brown, variably clast- and matrix-supported, mainly Tertiary pebbles <6 cm but with common non-Tertiary pebbles <6 cm, sub-angular to rounded and moderately to heavily rolled (could not describe in detail due to state of surface)

1304 Medium to coarse, yellowish to reddish brown **sand**, firm with rare small Tertiary pebbles <4 cm, common larger non-Tertiary pebbles <4 cm, sub-angular and moderately well rolled, occasional poorly developed wetting horizons (mineralisation laminations), very rare very small Tertiary pebbles and non-Tertiary pebbles chips, abraded

1305 As 1304

1306 As 1304

1307 As 1304

1308 Fine, yellowish to reddish brown **sand**, very firm with occasional Tertiary pebbles <2 cm and common non-Tertiary pebbles up to 10cm, sub-angular and moderately abraded; common root intrusions and black laminations and flecks, possibly due to root action

1309 Fine yellowish brown to green **Thanet Sand**, firm with occasional rooting in upper half, colour ranges from yellowish brown in upper half to green at base, due to modification (oxidation) in situ, horizontal and sub-horizontal wetting surfaces with conjugate faulting, Bullhead flint at base

1310 Moderate coarse, moderately well sorted, loose **gravel**, mostly Tertiary pebbles <4 cm, large non-Tertiary pebbles <6 cm, sub-angular to rounded and moderately abraded [N.B. 1310 same as 1303, may be due to loading deformation by the gravel sinking into the Thanet Sand. The sloping section probably leads to misleading view — 1310 is probably a lower downward extension of 1303]

SECTION 14

Site metre position 1430 m

1401 Variable reddish brown to dark reddish brown, loose **gravel**, variably clast- and matrix-supported, soil inclusions and loose structure suggest redeposition, possibly resulting from construction of adjacent sports centre

1402 Very coarse light brown dry dusty **gravel** (= 502)

1403 Medium to coarse, reddish brown **sand** with occasional small <2 cm Tertiary pebbles, rare larger non-Tertiary pebbles <6 cm, sub-angular and moderately rolled

1404 Moderately coarse, moderately well sorted, reddish brown **gravel**, variably clast- and matrix-supported, flints mostly Tertiary pebbles <4 cm, occasional non-Tertiary pebbles <6 cm, rounded to sub-angular and moderately abraded, firm with matrix of medium sand

1405 Moderately coarse, poorly sorted, yellowish to reddish brown, moderately loose to moderately firm **gravel**, variably clast- and matrix-supported, flints mostly Tertiary pebbles <6 cm, common larger non-Tertiary pebbles <15 cm, sub-angular and moderately well rolled, matrix of medium to coarse yellowish sand, sand (medium to coarse) wedge on right hand edge

1406 Firm to medium, reddish brown **sand**, firm with frequent small Tertiary pebbles <2 cm, also occasional larger non-Tertiary pebbles <10 cm in upper half, sub-angular to angular and moderate to well rolled

1407 Fine, greenish brown **Thanet Sand** with frequent horizontal red mineralisation laminae, firm, with rare small Tertiary pebbles <1 cm, very rare large Bullhead flint inclusions, large Bullhead flint common at interface with Chalk

1408 Solid **Chalk** bedrock

SECTION 15

Site metre position 1410 m

1501 Recent mixed **gravel and topsoil and backfill** with CBM (ceramic building materials) from construction of adjacent sports centre.

1502 Moderate (?), coarse, reddish brown **gravel**, moderately firm, variably clast- and matrix-supported, mainly Tertiary pebbles <4 cm, but with common non-Tertiary pebbles <4 cm, sub-angular to angular, moderately abraded, matrix of medium to coarse sand, larger non-Tertiary pebbles at base of context, sub-angular and moderately abraded, matrix becomes clay-rich towards base of context, particularly amount of larger non-Tertiary flints on right hand side of section.

1503 Fine yellowish brown to green **Thanet Sand** with frequent sub-horizontal wetting horizons, the angle of dip of these increases below the gravel 1502 on either side suggesting loading while almost vertical laminations in the centre suggest upwelling of a diaper, wetting horizons <1 cm, large tabular flint at base of Thanet Sand but no typical Bullhead staining

1504 **Chalk** bedrock

SECTION 16

Site metre position 1380 m

1601 Modern **redeposited gravel** with Ceramic Building Material and fine yellow building sand

1602 Fine, firm, yellowish brown to green **Thanet Sand**, left hand edge of block appears to have slid downwards into what may have been a solution hollow within the Chalk, wetting horizons <1 cm within upper yellowish brown Thanet Sand and clay-rich fracture seams strongly suggest sudden slumping as does the almost linear vertical interface (fault) between yellowish brown and green Tertiary Sand, downward extension of Thanet Sand into Chalk suggests infilling of solution hollow

1603 **Chalk** bedrock with solid blocks in right hand area of the section but more broken and degraded on the left hand side where collapse appears to have occurred

1604 Dark reddish brown (haematitic) **clay** at base of green Thanet Sand in particular, primarily along base of left hand part of section

SECTION 17

Site metre position 1350 m

1701 Dark brown **topsoil**/recent redeposited material

1702 Moderately coarse, moderately well sorted reddish brown **gravel**, variably clast- and matrix-supported, flints mostly Tertiary pebbles <4 cm with occasional non-Tertiary pebbles <6 cm, rounded to sub-angular and moderately abraded, firm with matrix of medium/coarse Sand

1703 Yellowish brown fine **Thanet Sand** , oxidised, with frequent sloping (east to west) wavy wetting-horizon laminae, occasional root intrusions

1704 Yellowish to greenish brown mixed, mottled, fine **sandy clay**, occasional pockets of reddish brown staining (mixed yellowish brown and green Thanet Sand

1705 Medium, greenish brown, fine sand (**Thanet Sand**) with frequent large well compacted reddish brown stained pockets of frequent large Bullhead flints at base

1706 Light yellowish brown fine **sand**, oxidised Thanet Sand, frequent horizontal and angled wavy wetting horizon laminations, stained (greenish) upper surface

1707 **Chalk** bedrock

N.B. In previous sections, all Thanet Sand was given the one context number, different colours separated by dotted lines. In this case they are given different numbers but all are Thanet Sand or mixed Thanet Sand

Interpretation

Mixed Thanet Sand (1704) – made up of yellowish brown oxidised Thanet Sand and green Thanet Sand into which has fallen/sunk blocks of pure yellowish brown Thanet Sand (1703 and 1704). Large solution or swallow hole in the Chalk points to vertical downward movement in this area

SECTION 18

Site metre position 1330 m

1801 Dark brown/black humic **topsoil**

1802 Dark yellowish brown, moderately coarse **sandy gravel**, disturbance associated with car parking for adjacent sports complex

1803 Medium reddish brown **silty clay** with frequent Tertiary pebbles <2 cm, occasional non-Tertiary pebbles <4 cm, sub-angular to angular, lightly abraded, firm with frequent root intrusion

1804 (Solid **Chalk** bedrock) – More likely Coombe rock – PA

1805 Light to medium greenish brown, fine **Thanet Sand**, frequent pockets and laminations of reddish brown staining, laminations follow the shape of the gravel body (1807)

1806 Light to medium yellowish brown, fine oxidised **Thanet Sand**, frequent fine wetting horizons which follow shape of enclosed gravel body (1809)

1807 Moderately coarse, yellowish to reddish brown **gravels**, variably clast- and matrix-supported, firm to moderately firm, mainly Tertiary pebbles <6 cm but also with common larger non-Tertiary pebbles <10 cm sub-angular to angular and moderately well abraded, larger non-Tertiary pebbles at top of gravel body, occasional sand pockets and lenses, firm yellowish to reddish brown medium to coarse fine sand, matrix of medium to coarse sand

1808 Light to medium yellowish brown fine **silty sand**, probably oxidised Thanet Sand, homogeneous with no laminations or wetting horizons

1809 As for 1807

1810 As for 1808 but reddish brown

1811 As for 1807 and 1809

SECTION 19

Site metre position 1760 m

1901 Dark brown/black humic subsoil

1902 Medium to coarse, yellowish to reddish brown **gravel**, variably clast- and matrix-supported, variably loose or moderately loose, mainly Tertiary pebbles <6 cm with frequent non-Tertiary pebbles including large clasts <12 cm, non-Tertiary pebbles angular to sub-angular, moderately to well rounded, matrix of medium to coarse sand, occasional fine root intrusions

Scale 1:50,000

Figure 1: Site location

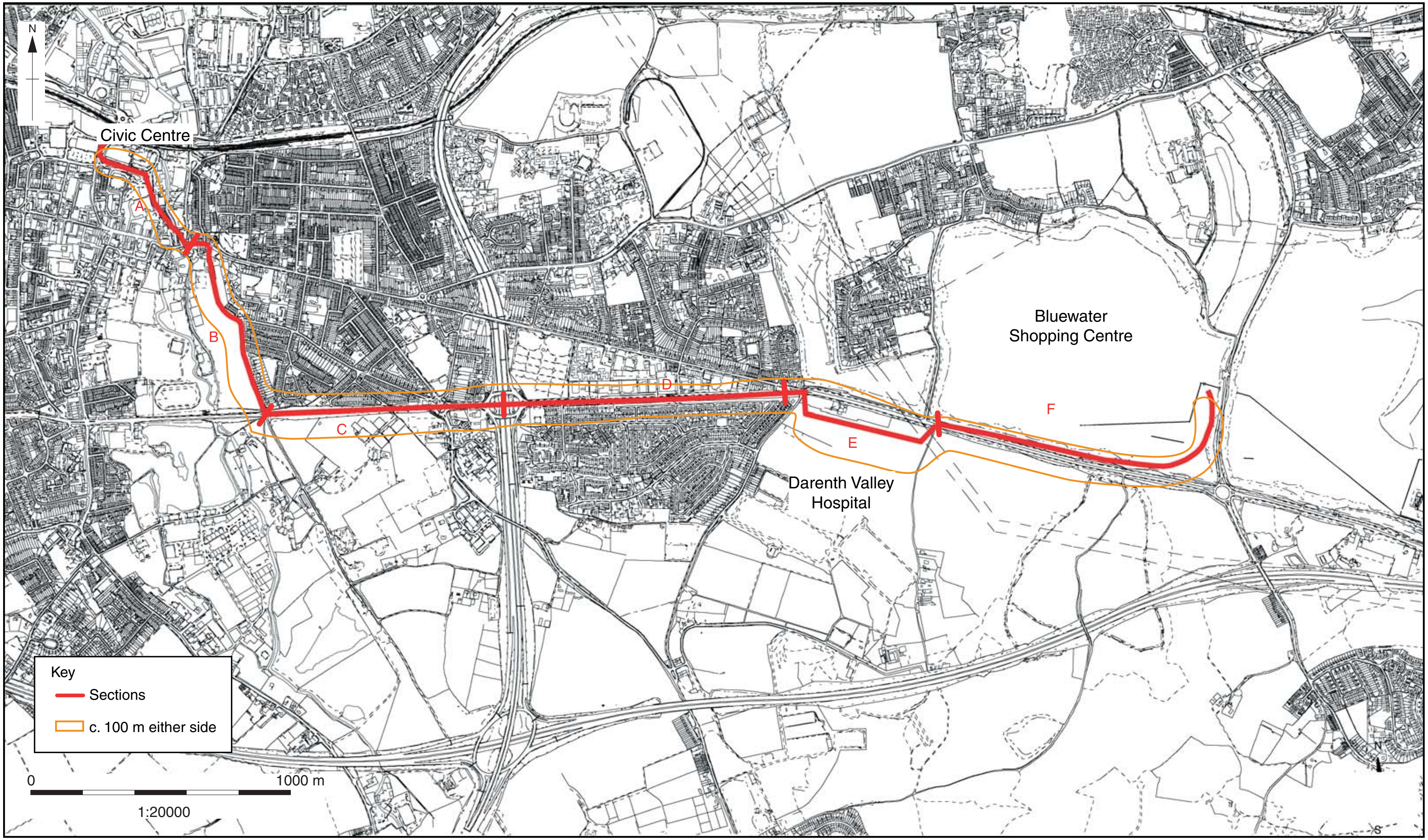
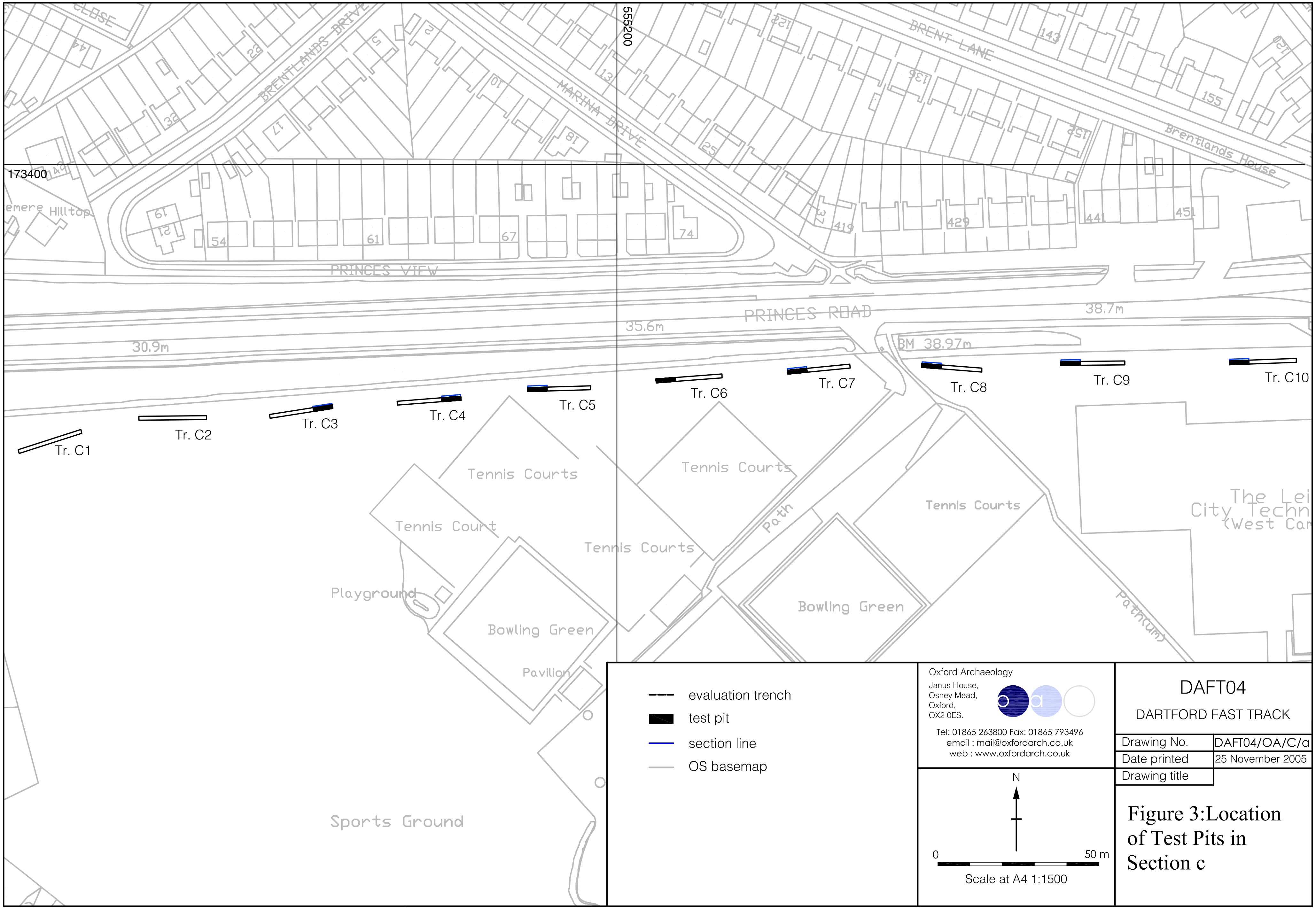


Figure 2: Route of Fastrack scheme, A to F

X:\Dartford_Fast_Track\Evaluation_DAFT_EV\Geomatics\CAD\current\DAFT04_current.dwg*RL/MEL*25.11.05



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DAFT04
DARTFORD FAST TRACK

Drawing No.	DAFT04/OA/C/a
Date printed	25 November 2005
Drawing title	

Figure 3: Location of Test Pits in Section c

CHECKED BY:MB*251105

Server 10:/oaupubs1_a thru h*DAFOOT 05*DAFOOTEV*Dartford Football Club*jm*25.11.05

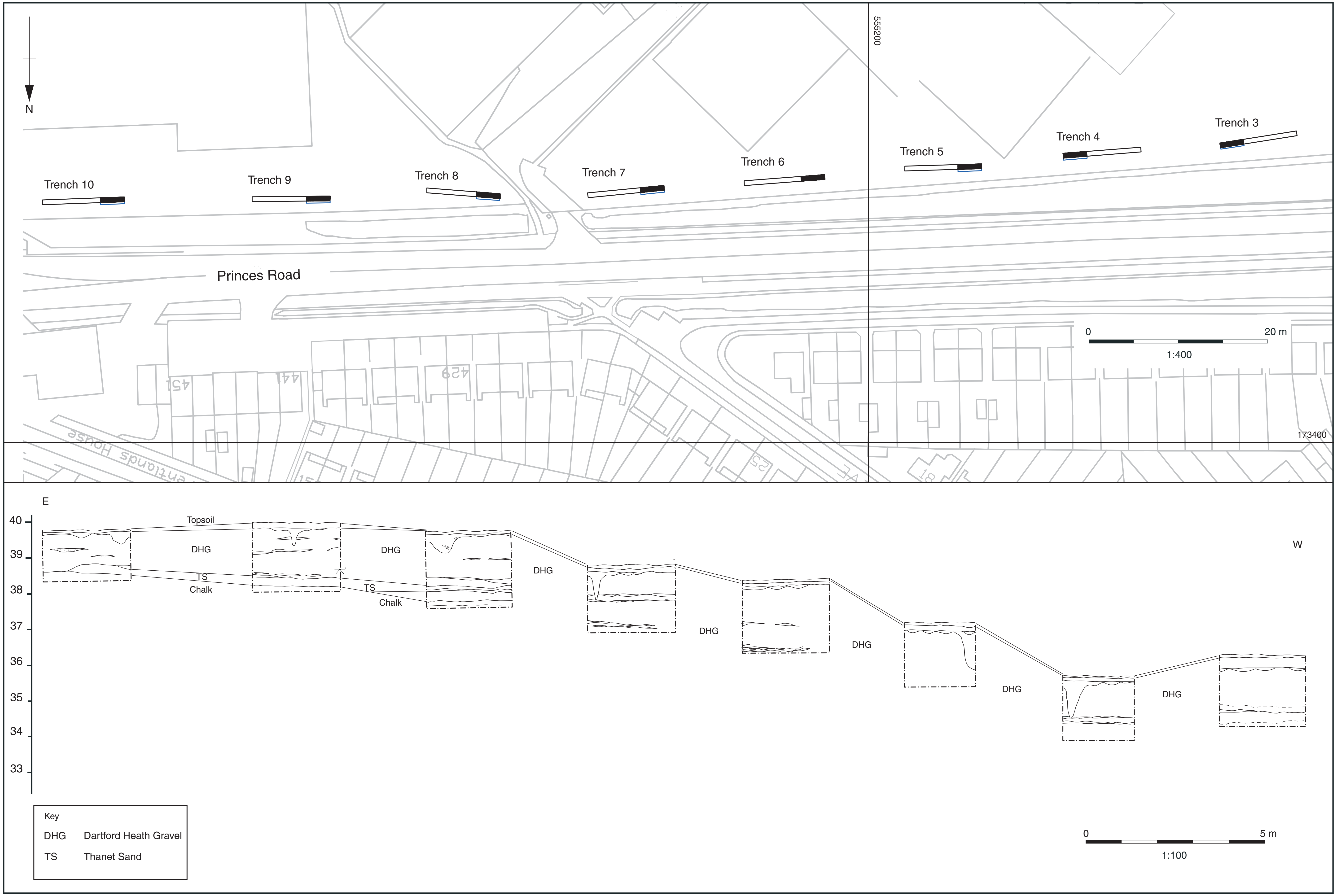

Figure 4: Schematic representation of the geology of Section C

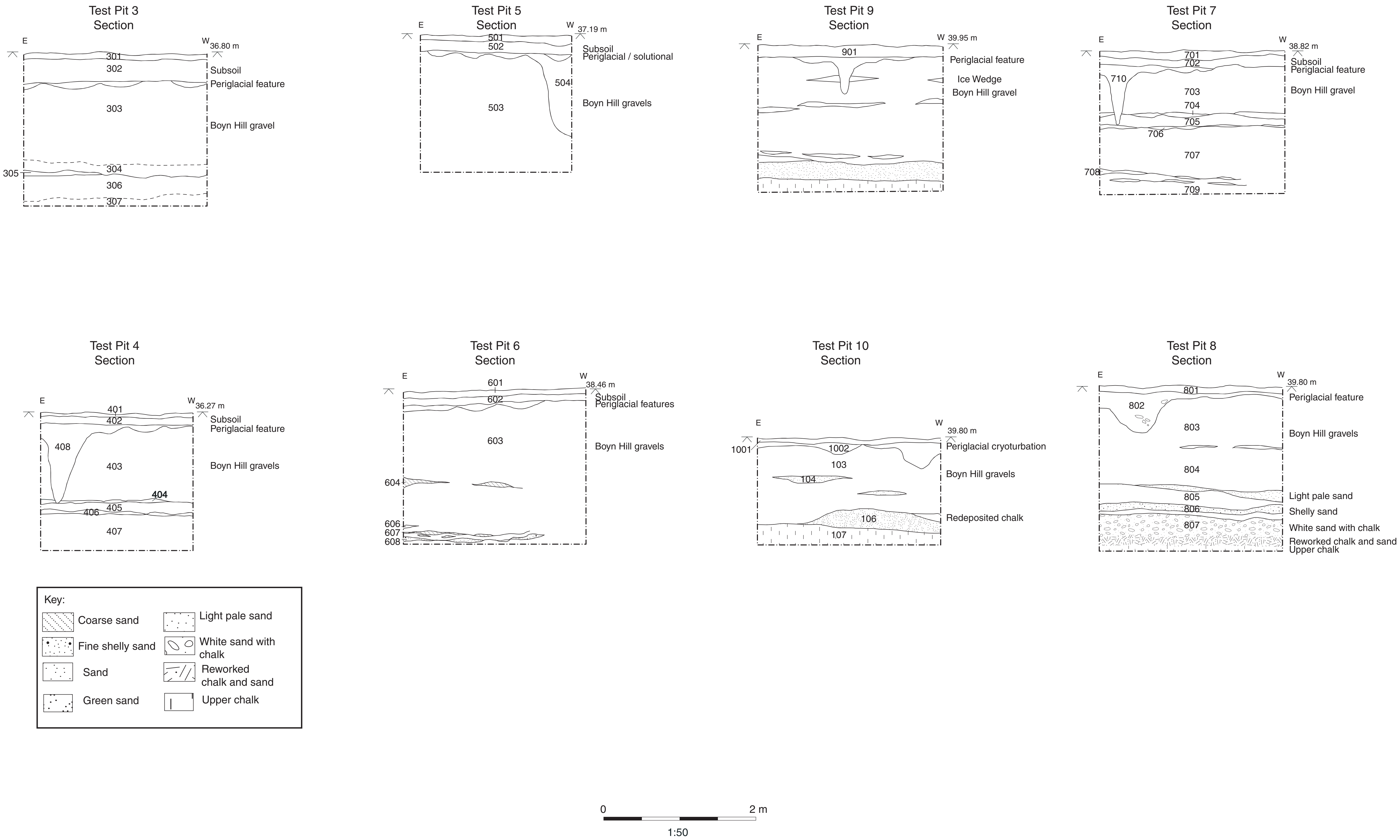

Figure 5: Test pits, 3, 4, 5, 7 and 8

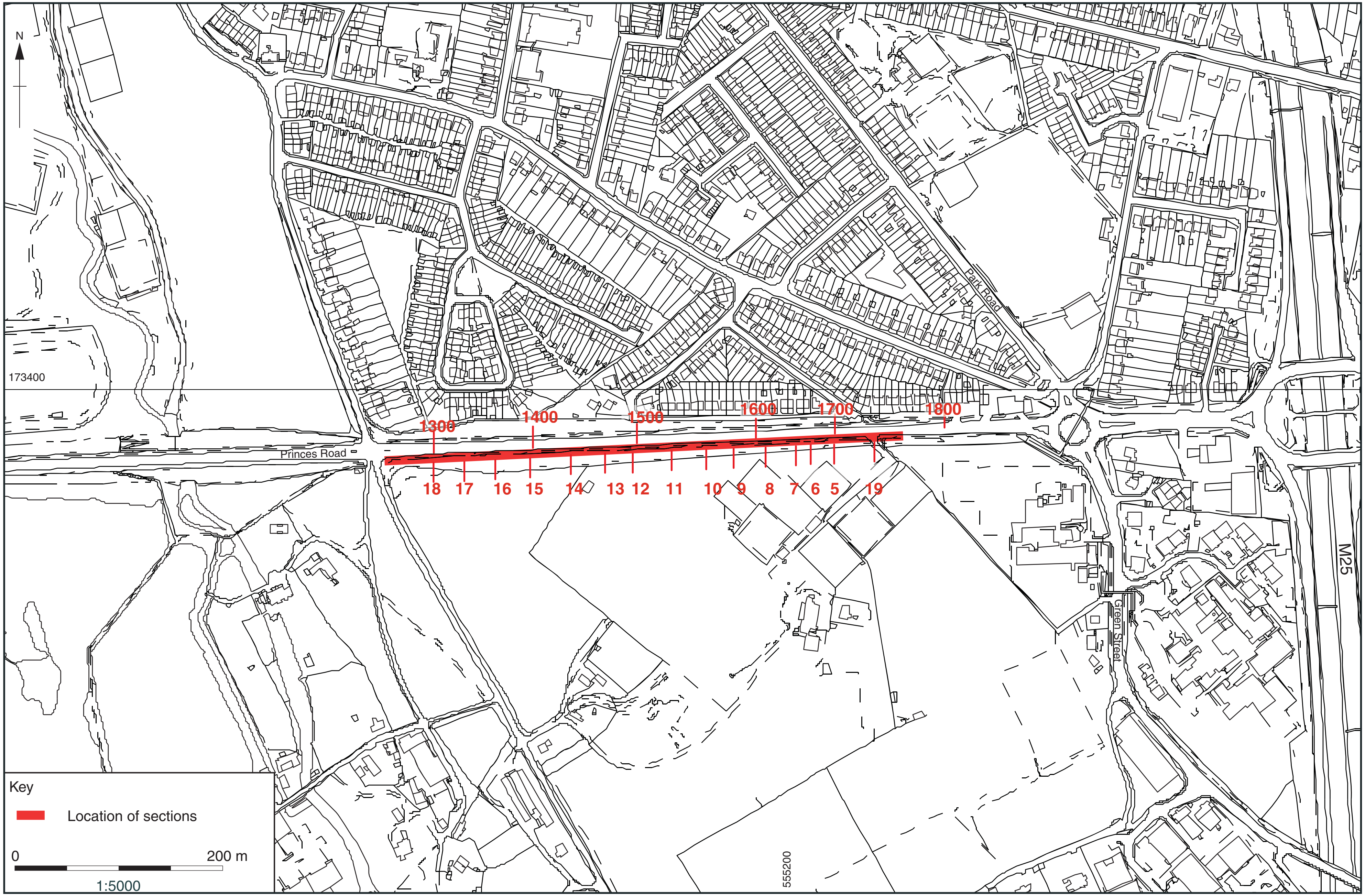

Figure 6: Layout of cleared sections (positions of sections marked approximate)

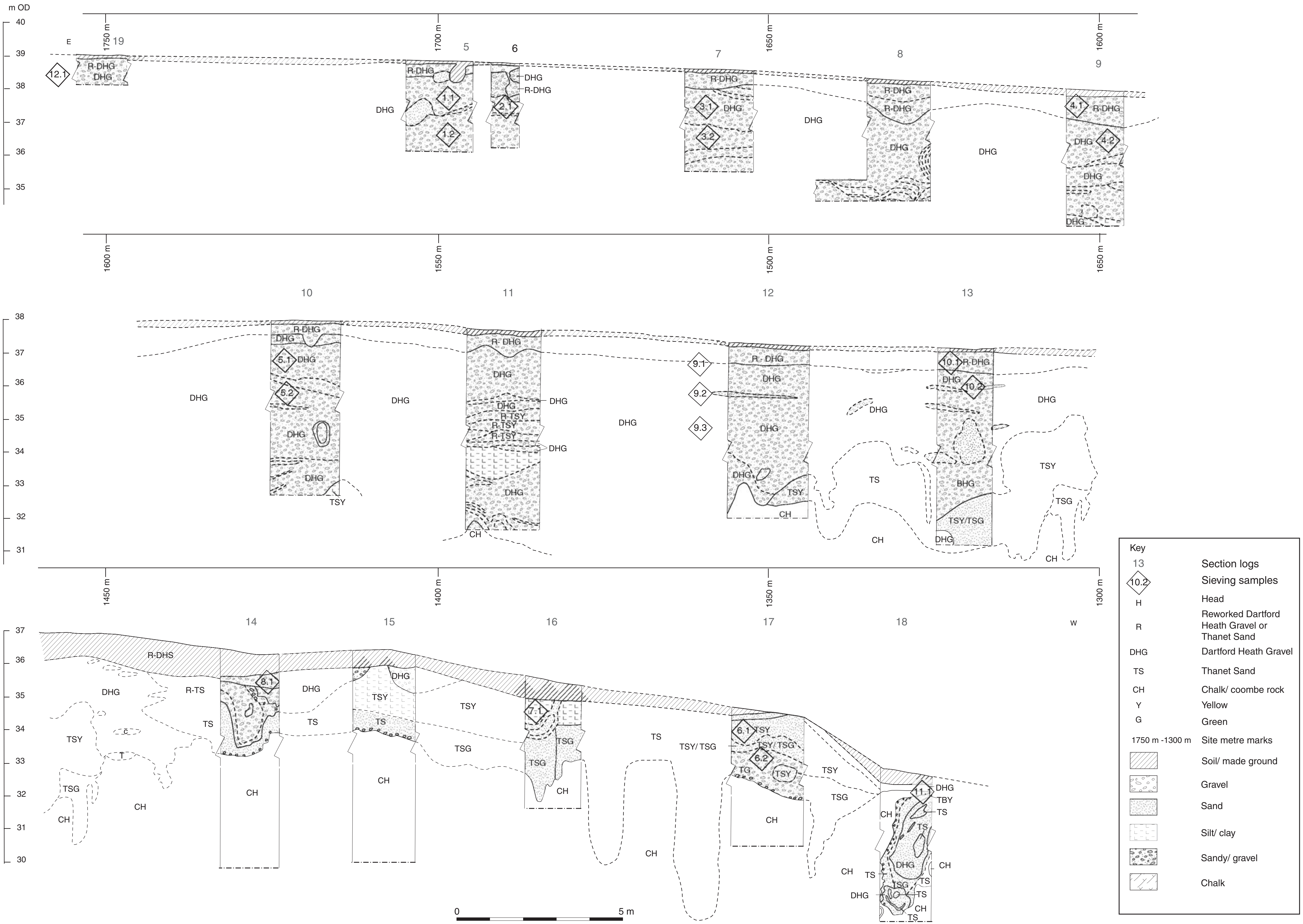

Figure 7: Schematic representation of the geology of Section C

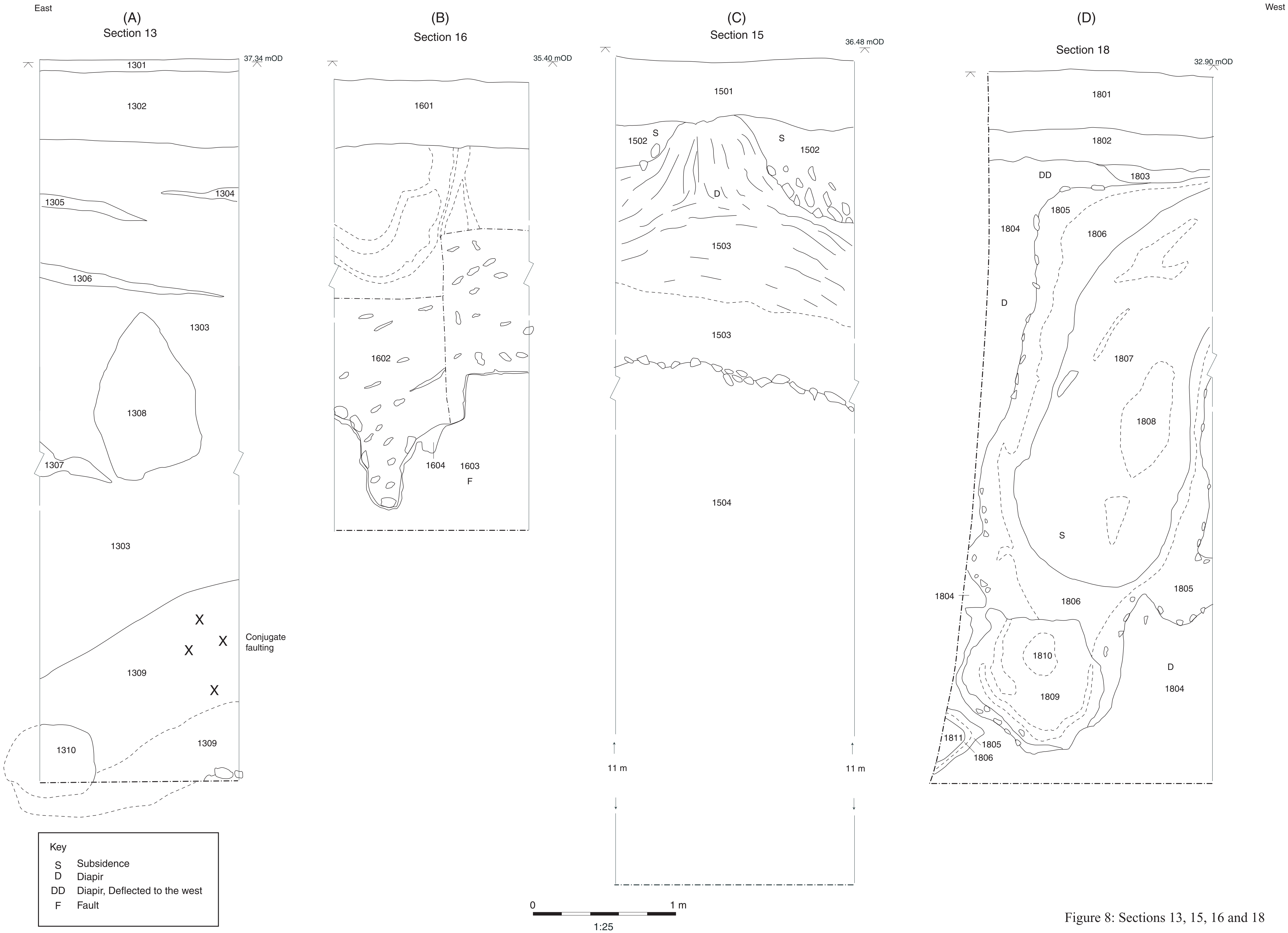

Figure 8: Sections 13, 15, 16 and 18

Plate 1: Groundworks in progress

Plate 2. Fluvially bedded sand bed in situ within main gravel body [scale 1 m]

Plate 3. View westwards, covering sections 11 (nearest camera) to 15 showing valley bulge of chalk and coombe rock (see text)