SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Land off Fengate Drove

Brandon, Suffolk & Weeting, Norfolk

Client:
Allenbuild Ltd

Date:
February 2016

BRD 189/ ESF 23245
ENF 140459
Archaeological Excavation Report
SACIC Report No. 2015/076
Author: Michael Green & John Craven
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Land off Fengate Drove, Brandon, Suffolk & Weeting, Norfolk

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Report Date: February 2016

HER Information

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Any opinions expressed in this report about the need for further archaeological work are those of the Field Projects Team alone. Ultimately the need for further work will be determined by the Local Planning Authority and its Archaeological Advisors when a planning application is registered. Suffolk County Council's archaeological contracting services cannot accept responsibility for inconvenience caused to the clients should the Planning Authority take a different view to that expressed in the report.

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The excavation of a new cross-section across the boundary revealed a similar profile to that seen in previous fieldwork, with a sequence of ditch cuts showing a boundary slightly shifting over time towards the north. The lack of a finds assemblage continues to suggest that the boundary is not immediately associated with any area of settlement and it is still assumed that later deposits in the stratigraphic sequence are of a medieval or post-medieval date, the boundary surviving as a tree/ fence line in the late 19th century.

A date for the origin of the boundary is still uncertain, despite the acquisition of two dates from Optical Spin Luminescence analysis of two separate samples. A tentative Anglo-Saxon date of 615 to 815 AD has been given for one of the earlier fills in the stratigraphic sequence but the validity of this result is dubious, it being stratigraphically contradictory to the second result which implies that neither date can be relied upon.

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Break in Section

Cut Number 0008

Deposit Number 0007

Ordnance Datum 18.45m OD

1. Introduction

1.1. Project Background

An archaeological excavation was carried out to further investigate known archaeological deposits on the proposed site of residential development at Fengate Drove, Brandon, Suffolk (Fig. 1).

The work was required by a condition on planning applications CD/14/2219 (Forest Heath District Council, Suffolk) and 3PL/2014/1361/F (Breckland District Council, Norfolk), in accordance with paragraph 141 of the National Planning Policy Framework, and was specified in a Brief (dated 02/04/2015) by Dr Richard Hoggett of Suffolk County Council Archaeological Service (SCCAS) with the agreement of James Albone of Norfolk Historic Environment Service (NCCHES), the respective archaeological advisers to the Local Planning Authorities (LPA's). This Brief specified a new stage of excavation of the known but hitherto undated county boundary ditch, with a view to collecting suitable sample material for scientific dating (Optical Spin Luminescence, referred to henceforth as OSL) which was addressed in a Suffolk Archaeology CIC (SACIC) Written Scheme of Investigation (Appendix 4).

1.2. Site location

The site covers an area of *c.*1.47ha and consists of a former timberyard lying between Fengate Drove and the railway line (Fig. 1), predominantly within the parish of Brandon, Suffolk but also extending north into Weeting, Norfolk. At this point the county boundary between Norfolk and Suffolk, which generally follows the course of the river, encloses a small area on the north bank as within Suffolk and passes through the north and western parts of the site.

1.3. Geology and topography

The site lies at a height of *c.*5-6m above Ordnance Datum, on the northern edge of the Little Ouse floodplain, with the river being 280m to the south.

The site geology consists of superficial river terrace deposits of sands and gravels, which overlie chalk bedrock of the Holywell Nodular Chalk Formation and New Pit Chalk Formation (British Geological Survey website).

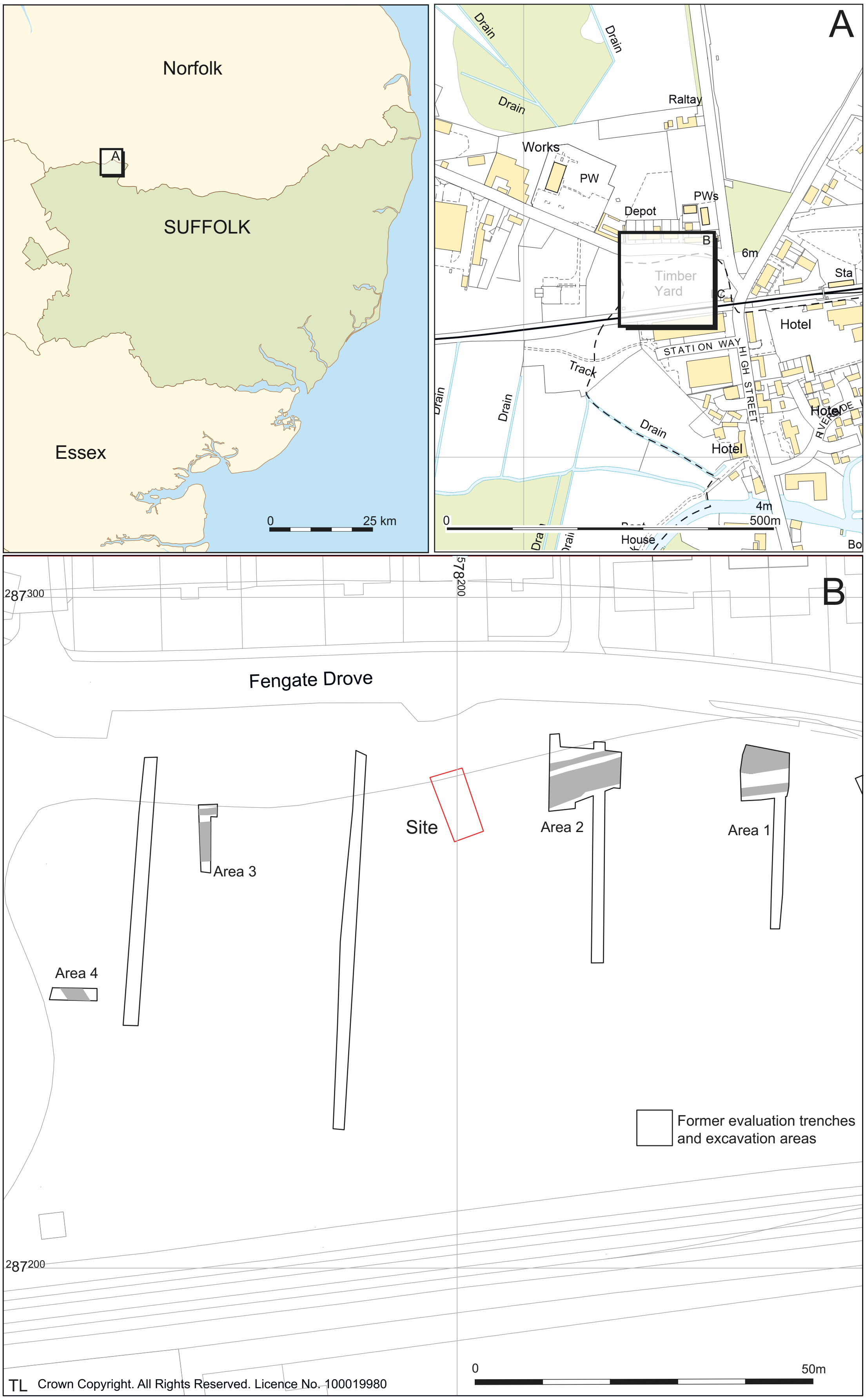

Figure 1. Location map

2. Archaeological and historical background

The site was initially deemed of interest by SCCAS during an earlier planning application in 2005, due to its location within 300m of the lowest known early medieval crossing across the river (Suffolk Historic Environment Record No. BRD 014), where possible timber remains of a bridging point have been noted and 80m north of the known indicative medieval settlement of Brandon (BRD 029). With the site also being situated on the county boundary between Norfolk and Suffolk it was therefore thought to have high potential for showing evidence of settlement from the Saxon or medieval periods.

An initial stage of trial trench evaluation (BRD 189, Craven 2005) confirmed the presence of a substantial ditch on the county boundary but otherwise there was a distinct lack of archaeological evidence predating the post-medieval period and the sites use as a timber yard.

Due to the depths of the evaluation trenches the ditch was not fully investigated and so a subsequent program of archaeological excavation was carried out with the aim of establishing the nature and size of the ditch, and the date of its infilling and abandonment (Craven 2006). This showed that the boundary ditch had apparently been infilled and recut at least three times, with its position gradually shifting to the north. Although the county boundary and its ditch are presumed to have originated in the Late Saxon-Early medieval period this remained unconfirmed as, despite the size of the ditch and its apparent prolonged use, there was very little artefactual material recovered. The finds consisted of a single pottery sherd of 15th/16th century date in an early deposit, a fragment of 15th century brick and a small collection of late medieval/post-medieval material indicating a possible final infilling and abandonment of the ditch in the late medieval/post-medieval periods.

3. Methodology

A new full cross-section of the ditch was excavated by a machine equipped with a back-acting arm and toothless ditching bucket (measuring 2.2m wide), under the supervision of an archaeologist. This involved the creation of a trench measuring 10m long and 5m wide being excavated to a depth of 1m, before a deeper central slot was placed. Excavation saw the removal of 0.6m of topsoil and 0.7m of mixed waterlain sands or modern deposits and subsoils until the cut of the ditch was clearly defined.

A mixture of hand excavation and machine clearance was then employed within the central trench to reach the base of the feature at 1.8m below the current ground surface. Trench and spoilheaps were scanned and metal-detected for artefactual material and the cross-section of the ditch was then cleaned and recorded by hand.

A single continuous numbering system was used to record all layers, features and other deposits on SACIC pro forma sheets. Registers for contexts, photographs, drawings and soil samples were maintained. The trench position and all levels were recorded by RTK GPS. Hand drawn plans at a scale of 1:50, and feature or trench sections at 1:20, were recorded on A3 pro-forma pregridded permatrace sheets. Digital colour photographs were taken of all stages of the fieldwork, and are included in the digital archive.

The excavation sampling strategy aimed to recover suitable material for OSL dating, to meet the primary aim of the project to date the ditch. Four samples were collected in accordance with advice provided by Dr P. S. Toms, School of Natural and Social Sciences, University of Gloucestershire, to whom two of the samples were sent for analysis (Appendix 1).

All samples were positioned at least 0.3m below the existing ground surface and if possible were 0.3m below any upper stratigraphic contact. The cross-section was cleaned until a surface whose moisture content has not been affected by surface drying was exposed. A 0.2m column sample was then collected using 40mm diameter black uPVC drainpipe (which will minimise light exposure) and wrapped in clingfilm and a thick opaque bag to minimise light exposure. After extracting the main dating sample a minimum of 100 g of sediment surrounding it, (lying roughly within a circle ~300 mm in radius) was collected and bagged.

The position of each column was recorded on the site plan and on a drawn section of the trench profile. Full data regarding position and height of each sample, and the thickness/composition of the section's stratigraphic units accompanied the samples when sent for analysis.

Site data has been input onto an MS Access database labelled with the County HER site code. All raw data from GPS survey has been uploaded to the project folder. All site drawings have been scanned and are included in the digital archive. Selected sections and plan drawings have been digitised as appropriate, the latter for combination with the results of digital site survey to produce a full site plan, compatible with MapInfo GIS software.

An OASIS form (Appendix 3) has been completed for the project (reference no. 224698) and a digital copy of the report has been submitted for inclusion on the Archaeology Data Service database (http://ads.ahds.ac.uk/catalogue/library/greylit).

The project archive, consisting of the complete artefactual assemblage, and all paper and digital records, will be deposited in the SCCAS Archaeological Store at Bury St Edmunds, Suffolk under HER No. BRD 189. The project archive will be consistent with MoRPHE (Historic England 2015) and ICON guidelines. The project archive will also meet the requirements of SCCAS (SCCAS 2010).

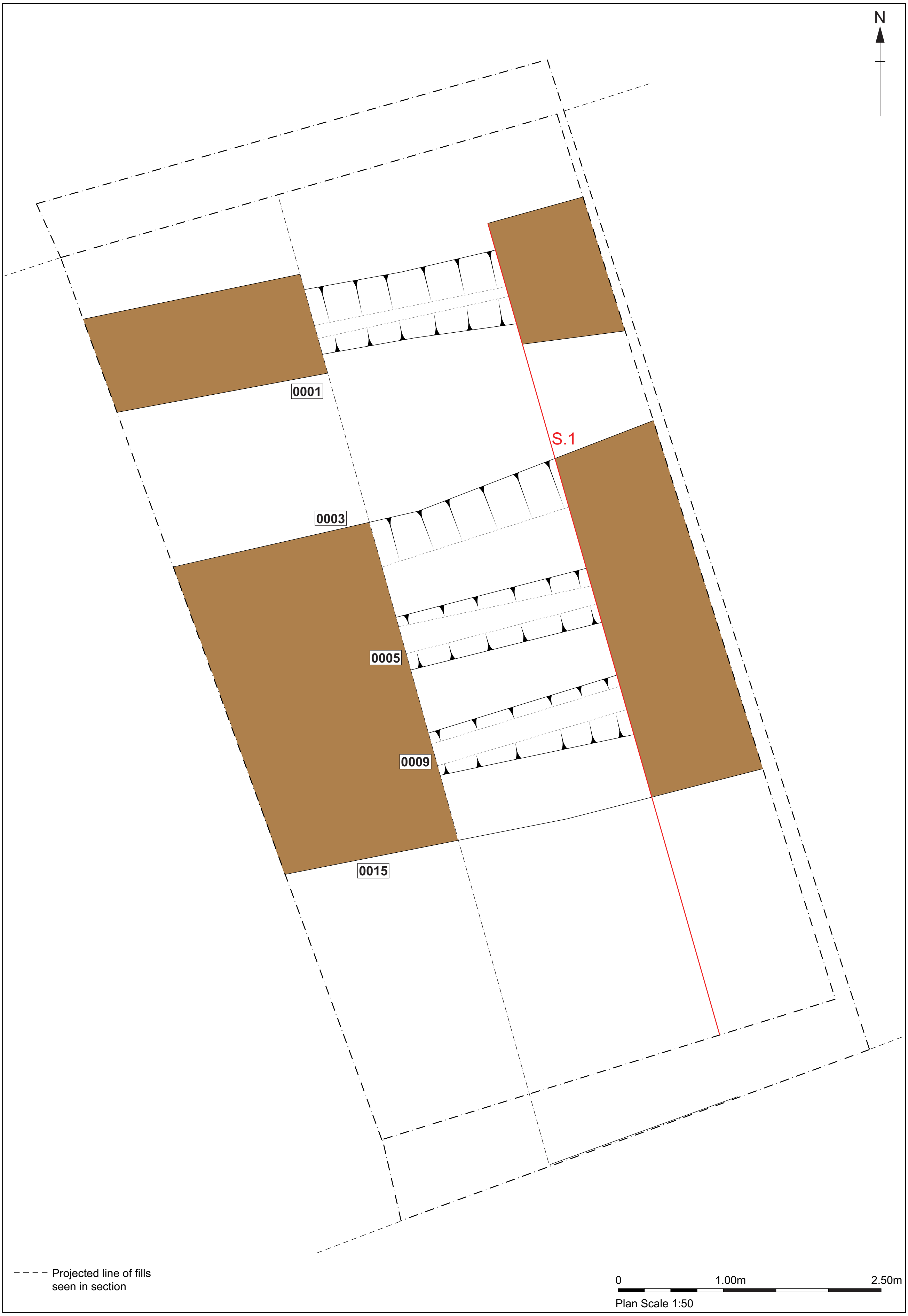

Figure 2. Site plan

4. Results

4.1. Introduction

The 10m x 5m excavation area was aligned north to south and exposed a full cross-section of the boundary. It was seen to consist of a series of ditch cuts and ditch re-cuts, with three potential earlier cuts followed by a series of five re-cuts that seem to be moving slightly north within the later phases (Fig. 3), in similar fashion to that seen in the earlier excavation.

No finds material was identified in any of the ditch fills, meaning that only relative phasing relationships between individual deposits could be ascertained based on stratigraphic relationships.

4.2. Feature descriptions

Ditch 0001

Linear in plan aligned east to west with a bowl shape profile concave sides and a concave base. This feature measured 1m in width and had a maximum depth seen of 0.44m and contained one fill. Fill 0002 was a dark grey brown loose sand with no clear inclusions. It was devoid of dating evidence. This was the most northern ditch set slightly apart from the main ditch cuts and re-cuts.

Ditch re-cut 0003

Linear in plan aligned east to west with sloped sides and a concave base, it was cut by ditch 0013 and cuts ditch re-cuts 0007 and 0011. It measured *c.* 3m in width and had a maximum depth of 1.1m and contained two fills. Fill 0004 was the top fill and a mid grey brown soft silty sand with occasional small flint inclusions, diffuse clarity and contained no finds. It had a maximum depth of 1.1m.

Basal fill/ slump 0017 was a light orange grey loose sand with no visible inclusions and diffuse clarity. It had a maximum depth of 0.18m and contained no dating evidence.

Ditch 0005

Linear in plan aligned east to west with concave sides and a concave base. It was cut by re-cut 0007 and measured 0.7m in width and 0.18m in depth. It contained one fill 0006 which was a light grey soft sand with frequent small and large flint inclusions. The fill had a clear clarity and contained no finds.

Ditch re-cut 0007

Linear in plan aligned east to west with an unclear profile, unclear sides and a flat base. It was cut by ditches 0003 and 0011 and cuts ditches 0005 and 0009 and measured 1.8m in width and had a maximum depth of 0.24m. It contained one fill 0008 which was a mixed mid grey, mid brown and mid orange loose sand with no inclusions, diffuse clarity and showed signs of recent bioturbation. The fill was devoid of dating evidence.

Ditch 0009

Linear in plan aligned east to west with a bowl shape profile, concave sides and a concave base. It was cut by ditch re-cuts 0007 and 0011 and measured 0.74m in width and 0.18m in depth. It contained one fill 0010 which was a light grey loose sand with moderate large and small flint inclusions, clear clarity and contained no dating evidence.

Ditch re-cut 0011

Linear in plan aligned east to west with a bowl shaped profile irregular concave sides and a flat base. This ditch re-cut was cut by ditch re-cut 0013 and 0003 and cuts ditch 0009 and 0015. It measured 3.82m in width and had a depth of 0.96m and contained one fill 0012 which was a mottled red-brown and mid grey sharp sand with occasional small flint inclusions. The fill contained no dating evidence.

Ditch re-cut 0013

Linear in plan aligned east to west with a bowl shaped profile, concave sides and a concave base. It cuts ditch 0003 and 0011 and was 0.54m in width and 0.24m in depth and contained one fill. Fill 0014 was a mid grey brown and mottled red brown soft sand with occasional small rounded flint pebbles and contained no finds.

Ditch 0015

Linear in plan aligned east to west with an unclear profile, concave base and irregular concave side. It was cut by ditch re-cut 0011 and measured 1.5m in width, 0.7m in depth and contained one fill. Fill 0016 was a pale grey soft fine sand with occasional iron pan inclusions, it had a clear clarity and contained no dating evidence.

Plate 1. Site after initial stripping
(1x1m and 1x2m scale)

Plate 2. The fully excavated cross-section
(1x1m and 1x2m scale)

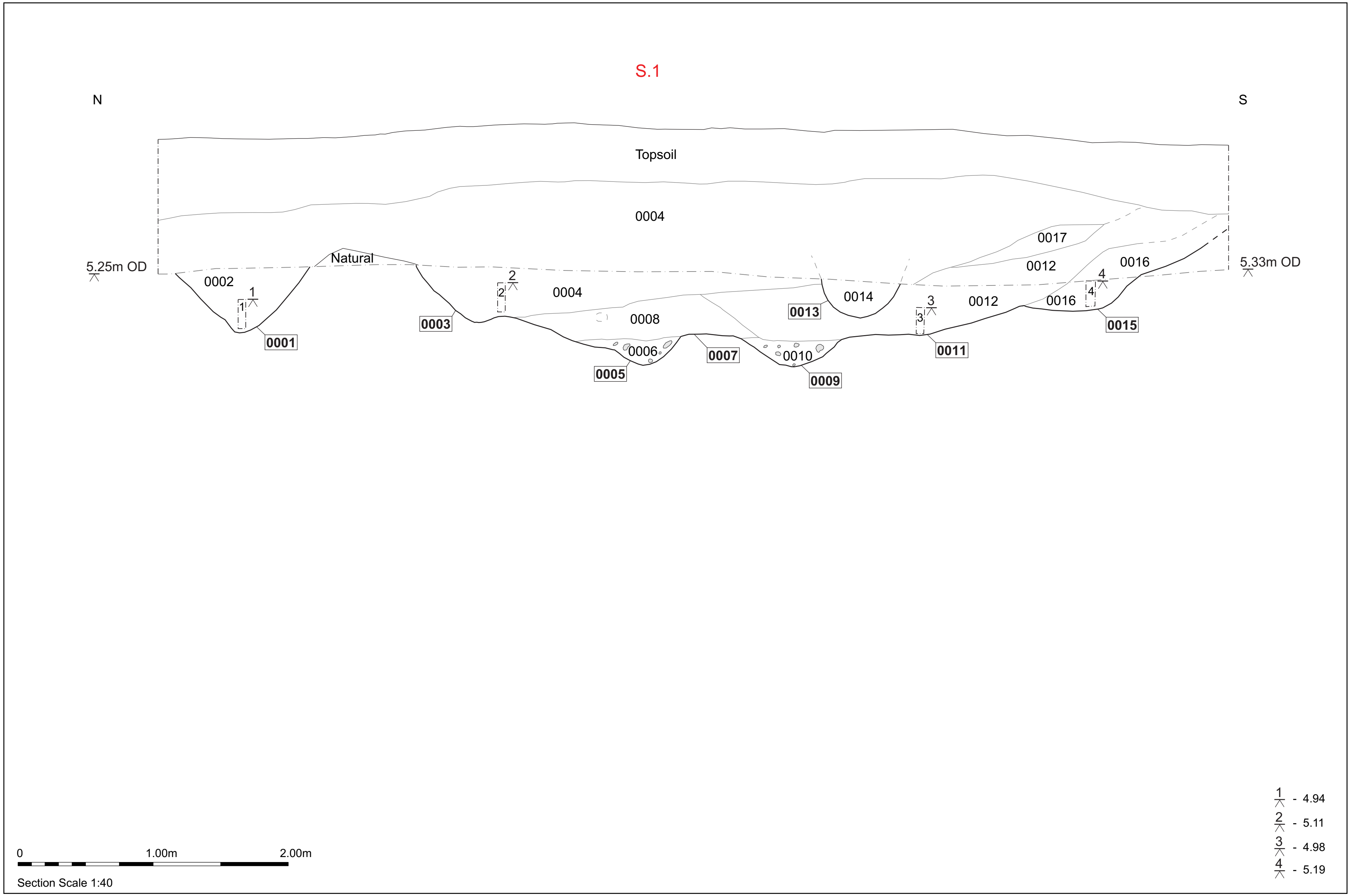

Figure 3. Section

4.3. OSL sampling

The main objective of the project was to obtain scientific dating evidence for the creation of the ditch through OSL analysis of basal ditch deposits. Following initial cleaning and recording four samples were collected from differing fills within the cross-section. These included:

- Sample 01: from fill 0002 in the stratigraphically separate ditch cut 0001.
- Sample 02: from fill 0004, of re-cut ditch 0003.
- Sample 03: from fill 0012, of re-cut ditch 0011.
- Sample 04: from fill 0016, of southernmost and relatively early ditch cut 0015.

Although the earliest deposits are likely to be fills 0006 and 0010, within ditch cuts 0005 and 0009, these were too small and contained too much in the way of flint inclusions to be suitable for sampling. Another relatively early deposit, 0008, was not sampled due to obvious signs of bioturbation and fills 0014 and 0017 were not sampled doing to be late in the deposition sequence.

Plate 3. Section showing sample positions
(1x1m and 1x2m scale)

Of the four samples 03 and 04 were subsequently selected for OSL dating, being considered to be the earliest of the sampled deposits and so best placed to provide a date relating to the early history of the boundary. Both samples stratigraphically proceeded Sample 02 which appears to be a relatively late deposit in the boundaries history while Sample 01, although having no immediate stratigraphic relationship, is also thought to be late in the deposition sequence due to its cut, 0001, being the northernmost ditch and therefore possibly at the end of the boundaries gradual northwards shift.

4.4. OSL dating results

Summary

The two samples were sent to Dr P. S. Toms at the University of Gloucestershire Luminescence Dating Laboratory for analysis, together with data from the site records. The analysis has produced the following results and the full technical report is included as Appendix 1. The results are discussed in section 5 below.

Sample 03: 185 B.C. - 215 A.D.

Sample 04: 615 A.D. - 815 A.D.

Reliability/quality of samples

Although the excavation sampling strategy followed the guidance provided by Dr P. S. Toms, as detailed in the methodology above, it should be noted that acquiring the samples proved problematic and may have affected their reliability. Although samples were placed at least 0.3m below the existing ground surface it was only just possible, for samples 03 and 04, to keep the top of the column 0.3m below the upper stratigraphic contact.

In addition the nature and origin of the ditch deposits may have affected the results. Although deposits such as 0012 and 0016 appeared relatively homogenous it is thought unlikely that they were laid down in single short instances of deposition and subsequently buried undisturbed. Instead the generally loose or soft sands are likely in practice to have developed gradually over long periods through natural processes such as slumping or windblown deposition, such as typically seen in archaeological sites across the Breckland or fen-edge environments of north-western Suffolk, with subsequent movement and probable bioturbation mixing separate lenses of material into a single deposit. Parts of any single deposit, and hence sample, may therefore have been laid down or seen their last exposure to sunlight, at different times.

5. Discussion

Excavation of the ditched boundary has shown a similar pattern to that of previous excavations, with a series of at least four significant stages of ditch cut and re-cut shifting the boundary gradually northwards. Infilling deposits again show a tendency to slump into the ditch from the southern side. Also in keeping with previous work was the lack of dating evidence found within the features and the previous assumption (Craven 2006) that the lack of material may be because there was no area of occupation adjacent to this part of the ditch remains valid.

Previous work also suggested that, if the county boundary ditch did originate in the Late Saxon to Early medieval period as the town of Brandon developed, then early deposits could have been largely removed by the series of recuts and that surviving later fills could simply represent a possible final infilling and abandonment of the ditch in the late medieval to post-medieval periods. A combination of the latest fieldwork results and lack of a finds assemblage with the results of the OSL analysis on two of the collected samples do not contradict this assumption and it seems probable that later deposits in the sequence are of a medieval or post-medieval date, with the ditches all being infilled by the late 19th century when, on the First Edition Ordnance Survey of *c.*1880, the boundary is simply shown as a line of trees and possible fenceline (Craven 2006).

The two dates obtained from the OSL analysis are of a mixed nature. The specialist report notes that each date is subject to a technical caveat regarding accuracy, and it is immediately apparent that they are stratigraphically inconsistent.

The stratigraphy suggests that at least one of the dates is erroneous with Sample 03, which is stratigraphically later than Sample 04, having a significantly earlier date estimate ranging across the Late Iron Age to mid Roman period. Based on the scant finds evidence in previous work, the stratigraphic position of the deposit and the general belief that the ditched boundary is of Anglo-Saxon date or later it seems likely that Sample 03 has given a false result.

The date of Sample 04 however, if accurate, is an important result demonstrating that an early stage of the historic boundary dates to the Anglo-Saxon period. However the accuracy of the result has to be regarded as questionable, it being equally as reliable as the apparently erroneous Sample 03 and any decision to trust the date of one sample more than the other has no solid basis.

It is suggested that the nature of the boundary, with its series of ditch cuts and infilling deposits, has affected the projects ability to collect reliable samples and obtain an accurate date. Firstly the infilling deposits are relatively thin, meaning the required 300mm margin between sample and any upper stratigraphic contact has been difficult to achieve. Secondly the lack of finds indicates that infilling of the ditches has occurred on a gradual basis through natural processes such as slumping or windblown deposition and this, combined with other probable bioturbation, means that any single deposit may not be sufficiently homogeneous for a reliable result.

6. Conclusion

The excavation of a new cross-section across the Suffolk/Norfolk county boundary has revealed a similar profile to that previously seen, with a sequence of ditch cuts showing a boundary slightly shifting over time towards the north. The lack of a finds assemblage continues to suggest that the boundary is not immediately associated with any area of settlement and it is still assumed that later deposits in the stratigraphic sequence are of a medieval or post-medieval date, the boundary surviving as a tree/ fence line in the late 19th century.

A date for the origin of the boundary is still uncertain, despite the acquisition of two dates from Optical Spin Luminescence analysis of two separate samples. A tentative Anglo-Saxon date of 615 to 815 AD has been given for one of the earlier fills in the stratigraphic sequence but the validity of this result is dubious, it being stratigraphically contradictory to the second result which implies that neither date can be relied upon.

7. Archive deposition

The project archives, consisting of paper and digital records, will be deposited with the Suffolk County Council Archaeological Service.

8. Acknowledgements

Project management was undertaken by John Craven. The fieldwork was carried out by Michael Green and Simon Cass and directed by Michael Green.

The report was written by Michael Green and John Craven, with illustrations by Eleanor Cox and Michael Green. The specialist Optical Spin Luminescence report was produced by Dr P. S. Toms, University of Gloucestershire.

9. Bibliography

Craven, J. A., 2005, *Land off Fengate Drove, Brandon, BRD 189, a Report on the Archaeological Evaluation.* SCCAS Report No. 2005/176.

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Websites

British Geological Survey

http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Appendix 1. Optical Spin Luminescence

University of Gloucestershire

Luminescence dating laboratory

Optical dating of sediments: Fengate Drove excavations

to

J. Craven

Suffolk Archaeology

Prepared by Dr P.S. Toms, 02 Feb 2016

Contents

Scope of Report

This is a standard report of the Luminescence dating laboratory, University of Gloucestershire. In large part, the document summarises the processes, diagnostics and data drawn upon to deliver Table 1. A conclusion on the analytical validity of each sample's optical age estimate is expressed in Table 2; where there are caveats, the reader is directed to the relevant section of the report that explains the issue further in general terms.

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Permission must be sought from Dr P.S. Toms of the University of Gloucestershire Luminescence dating laboratory in using the content of this report, in part or whole, for the purpose of publication.

Field Code	Lab Code	Overburden (m)	Grain size (μm)	Moisture content (%)	NaI γ-spectrometry (*in situ*)			γ D_r ($Gy.ka^{-1}$)	Ge γ-spectrometry (*ex situ*)			β D_r ($Gy.ka^{-1}$)	Cosmic D_r ($Gy.ka^{-1}$)	Preheat (°C for 10s)	Low Dose Repeat Ratio	Interpolated:Applied Low Regenerative-dose D_e	High Dose Repeat Ratio	Interpolated:Applied High Regenerative-dose D_e	Post-IR OSL Ratio
					K (%)	Th (ppm)	U (ppm)		K (%)	Th (ppm)	U (ppm)								
BRD189 3	GL15079	1.30	125-180	6 ± 2	-	-	-	0.16 ± 0.04	0.47 ± 0.04	0.64 ± 0.27	0.27 ± 0.10	0.37 ± 0.05	0.17 ± 0.02	280	0.97 ± 0.01	1.00 ± 0.02	0.99 ± 0.01	0.97 ± 0.01	0.97 ± 0.01
BRD189 4	GL15080	1.01	125-180	5 ± 1	-	-	-	0.14 ± 0.04	0.34 ± 0.03	0.66 ± 0.16	0.27 ± 0.07	0.28 ± 0.04	0.18 ± 0.02	280	1.01 ± 0.02	1.03 ± 0.02	1.01 ± 0.01	1.00 ± 0.01	1.00 ± 0.02

Field Code	Lab Code	Total D_r ($Gy.ka^{-1}$)	D_e (Gy)	Age (ka)	Date
BRD189 3	GL15079	0.70 ± 0.05	1.41 ± 0.12	2.0 ± 0.2 (0.2)	185 B.C. - 215 A.D.
BRD189 4	GL15080	0.60 ± 0.04	0.78 ± 0.06	1.3 ± 0.1 (0.1)	615 A.D. - 815 A.D.

Table 1 D_r, D_e and Age data of submitted samples located at c. 52°N, 1°E, 6m. Age estimates expressed relative to year of sampling. Uncertainties in age are quoted at 1σ confidence, are based on analytical errors and reflect combined systematic and experimental variability and (in parenthesis) experimental variability alone (see 6.0). Blue indicates samples with accepted age estimates, red, age estimates with caveats (see Table 2).

Generic considerations	Field Code	Lab Code	Sample specific considerations
None	BRD189 3	GL15079	Possible significant U disequilibrium (section 4.0 & Fig. 7), though at detection limits of equipment.
	BRD189 4	GL15080	Possible significant U disequilibrium (section 4.0 & Fig. 7), though at detection limits of equipment.

Table 2 Analytical validity of sample suite age estimates and caveats for consideration

1.0 Mechanisms and principles

Upon exposure to ionising radiation, electrons within the crystal lattice of insulating minerals are displaced from their atomic orbits. Whilst this dislocation is momentary for most electrons, a portion of charge is redistributed to meta-stable sites (traps) within the crystal lattice. In the absence of significant optical and thermal stimuli, this charge can be stored for extensive periods. The quantity of charge relocation and storage relates to the magnitude and period of irradiation. When the lattice is optically or thermally stimulated, charge is evicted from traps and may return to a vacant orbit position (hole). Upon recombination with a hole, an electron's energy can be dissipated in the form of light generating crystal luminescence providing a measure of dose absorption.

Herein, quartz is segregated for dating. The utility of this minerogenic dosimeter lies in the stability of its datable signal over the mid to late Quaternary period, predicted through isothermal decay studies (e.g. Smith *et al*., 1990; retention lifetime 630 Ma at 20°C) and evidenced by optical age estimates concordant with independent chronological controls (e.g. Murray and Olley, 2002). This stability is in contrast to the anomalous fading of comparable signals commonly observed for other ubiquitous sedimentary minerals such as feldspar and zircon (Wintle, 1973; Templer, 1985; Spooner, 1993)

Optical age estimates of sedimentation (Huntley *et al*., 1985) are premised upon reduction of the minerogenic time dependent signal (Optically Stimulated Luminescence, OSL) to zero through exposure to sunlight and, once buried, signal reformulation by absorption of litho- and cosmogenic radiation. The signal accumulated post burial acts as a dosimeter recording total dose absorption, converting to a chronometer by estimating the rate of dose absorption quantified through the assay of radioactivity in the surrounding lithology and streaming from the cosmos.

$$\text{Age} = \frac{\text{Mean Equivalent Dose } (D_e, \text{ Gy})}{\text{Mean Dose Rate } (D_r, \text{ Gy.ka}^{-1})}$$

Aitken (1998) and Bøtter-Jensen et al. (2003) offer a detailed review of optical dating.

2.0 Sample Preparation

Two sediment samples were submitted within opaque tubing for Optical dating. To preclude optical erosion of the datable signal prior to measurement, all samples were opened and prepared under controlled laboratory illumination provided by Encapsulite RB-10 (red) filters. To isolate that material potentially exposed to daylight during sampling, sediment located within 20 mm of each tube-end was removed.

The remaining sample was dried, sieved and then subjected to acid and alkaline digestion (10% HCl, 15% H_2O_2) to attain removal of carbonate and organic components respectively. The fine sand fraction underwent a further acid digestion in HF (40%, 60 mins) was used to etch the outer 10-15 μm layer affected by α radiation and degrade each samples' feldspar content. During HF treatment, continuous magnetic stirring was used to effect isotropic etching of grains. 10% HCl was then added to remove acid soluble fluorides. Each sample was dried, resieved and quartz isolated from the remaining heavy mineral fraction using a sodium polytungstate density separation at 2.68g.cm^{-3}. Twelve 8 mm multi-grain aliquots (*c*. 3-6 mg) of quartz from each sample were then mounted on aluminium discs for determination of D_e values.

All drying was conducted at 40°C to prevent thermal erosion of the signal. All acids and alkalis were Analar grade. All dilutions (removing toxic-corrosive and non-minerogenic luminescence-bearing substances) were conducted with distilled water to prevent signal contamination by extraneous particles.

3.0 Acquisition and accuracy of D_e value

All minerals naturally exhibit marked inter-sample variability in luminescence per unit dose (sensitivity). Therefore, the estimation of D_e acquired since burial requires calibration of the natural signal using known amounts of laboratory dose. D_e values were quantified using a single-aliquot regenerative-dose (SAR) protocol (Murray and Wintle 2000; 2003) facilitated by a Risø TL-DA-15 irradiation-stimulation-detection system (Markey *et al*., 1997; Bøtter-Jensen *et al*., 1999). Within this apparatus, optical signal stimulation is provided by an assembly of blue diodes (5 packs of 6 Nichia NSPB500S), filtered to 470±80 nm conveying 15 $mW.cm^{-2}$ using a 3 mm Schott GG420 positioned in front of each diode pack. Infrared (IR) stimulation, provided by 6 IR diodes (Telefunken TSHA 6203) stimulating at 875±80nm delivering ~5 $mW.cm^{-2}$, was used to indicate the presence of contaminant feldspars (Hütt *et al*., 1988). Stimulated photon emissions from quartz aliquots are in the ultraviolet (UV) range and were filtered from stimulating photons by 7.5 mm HOYA U-340 glass and detected by an EMI 9235QA photomultiplier fitted with a blue-green sensitive bialkali photocathode. Aliquot irradiation was conducted using a 1.48 GBq $^{90}Sr/^{90}Y$ β source calibrated for multi-grain aliquots of 125-180 μm quartz fraction against the 'Hotspot 800' ^{60}Co γ source located at the National Physical Laboratory (NPL), UK.

SAR by definition evaluates D_e through measuring the natural signal (Fig. 1) of a single aliquot and then regenerating that aliquot's signal by using known laboratory doses to enable calibration. For each aliquot, 5 different regenerative-doses were administered so as to image dose response. D_e values for each aliquot were then interpolated, and associated counting and fitting errors calculated, by way of exponential plus linear regression (Fig. 1). Weighted (geometric) mean D_e values were calculated from 12 aliquots using the central age model outlined by Galbraith *et al*. (1999) and are quoted at 1σ confidence (Table 1). The accuracy with which D_e equates to total absorbed dose and that dose absorbed since burial was assessed. The former can be considered a function of laboratory factors, the latter, one of environmental issues. Diagnostics were deployed to estimate the influence of these factors and criteria instituted to optimise the accuracy of D_e values.

3.1 Laboratory Factors

3.1.1 Feldspar contamination

The propensity of feldspar signals to fade and underestimate age, coupled with their higher sensitivity relative to quartz makes it imperative to quantify feldspar contamination. At room temperature, feldspars generate a signal (IRSL; Fig. 1) upon exposure to IR whereas quartz does not. The signal from feldspars contributing to OSL can be depleted by prior exposure to IR. For all aliquots the contribution of any remaining feldspars was estimated from the OSL IR depletion ratio (Duller, 2003). The influence of IR depletion on the OSL signal can be illustrated by comparing the regenerated post-IR OSL D_e with the applied regenerative-dose (Fig. 5). If the addition to OSL by feldspars is insignificant, then the repeat dose ratio of OSL to post-IR OSL should be statistically consistent with unity (Table 1). If any aliquots do not fulfil this criterion, then the sample age estimate should be accepted tentatively. The source of feldspar contamination is rarely rooted in sample preparation; it predominantly results from the occurrence of feldspars as inclusions within quartz.

3.1.2 Preheating

Preheating aliquots between irradiation and optical stimulation is necessary to ensure comparability between natural and laboratory-induced signals. However, the multiple irradiation and preheating steps that are required to define single-aliquot regenerative-dose response leads to signal sensitisation, rendering calibration of the natural signal inaccurate. The SAR protocol (Murray and Wintle, 2000; 2003) enables this sensitisation to be monitored and corrected using a test dose, here set at 5 Gy preheated to 220°C for 10s, to track signal sensitivity between irradiation-preheat steps. However, the accuracy of sensitisation correction for both natural and laboratory signals can be preheat dependent.

The Dose Recovery test was used to assess the optimal preheat temperature for accurate correction and calibration of the time dependent signal. Dose Recovery (Fig. 2) attempts to quantify the combined effects of thermal transfer and sensitisation on the natural signal, using a precise lab dose to simulate natural dose. The ratio between the applied dose and recovered D_e value should be statistically concordant with unity. For this diagnostic, 6 aliquots were each assigned a 10 s preheat between 180°C and 280°C.

That preheat treatment fulfilling the criterion of accuracy within the Dose Recovery test was selected to generate the final D_e value from a further 12 aliquots. Further thermal treatments, prescribed by Murray and Wintle (2000; 2003), were applied to optimise accuracy and precision. Optical stimulation occurred at 125ºC in order to minimise effects associated with photo-transferred thermoluminescence and maximise signal to noise ratios. Inter-cycle optical stimulation was conducted at 280ºC to minimise recuperation.

3.1.3 Irradiation

For all samples having D_e values in excess of 100 Gy, matters of signal saturation and laboratory irradiation effects are of concern. With regards the former, the rate of signal accumulation generally adheres to a saturating exponential form and it is this that limits the precision and accuracy of D_e values for samples having absorbed large doses. For such samples, the functional range of D_e interpolation by SAR has been verified up to 600 Gy by Pawley *et al*. (2010). Age estimates based on D_e values exceeding this value should be accepted tentatively.

3.1.4 Internal consistency

Quasi-radial plots (*cf* Galbraith, 1990) are used to illustrate inter-aliquot D_e variability for natural, repeat regenerative-dose and post-IR OSL signals (Figs 3 to 5, respectively). D_e values are standardised relative to the central D_e value for natural signals and applied dose for regenerated signals. D_e values are described as overdispersed when >5% lie beyond $\pm$ 2σ of the standardising value; resulting from a heterogeneous absorption of burial dose and/or response to the SAR protocol. For multi-grain aliquots, overdispersion of natural signals does not necessarily imply inaccuracy. However where overdispersion is observed for regenerated signals, the efficacy of sensitivity correction may be problematic. Murray and Wintle (2000; 2003) suggest repeat dose ratios (Table 1) offer a measure of SAR protocol success, whereby ratios ranging across 0.9-1.1 are acceptable. However, this variation of repeat dose ratios in the high-dose region can have a significant impact on D_e interpolation. The influence of this effect can be outlined by quantifying the ratio of interpolated to applied regenerative-dose ratio (Table 1, Fig. 4). In this study, where both the repeat dose ratios and interpolated to applied regenerative-dose ratios range across 0.9-1.1, sensitivity-correction is considered effective.

3.2 Environmental factors

3.2.1 Incomplete zeroing

Post-burial OSL signals residual of pre-burial dose absorption can result where pre-burial sunlight exposure is limited in spectrum, intensity and/or period, leading to age overestimation. This effect is particularly acute for material eroded and redeposited sub-aqueously (Olley *et al*., 1998, 1999; Wallinga, 2002) and exposed to a burial dose of <20 Gy (e.g. Olley *et al*., 2004), has some influence in sub-aerial contexts but is rarely of consequence where aerial transport has occurred. Within single-aliquot regenerative-dose optical dating there are two diagnostics of partial resetting (or bleaching); signal analysis (Agersnap-Larsen *et al*., 2000; Bailey *et al*., 2003) and inter-aliquot D_e distribution studies (Murray *et al*., 1995).

Within this study, signal analysis was used to quantify the change in D_e value with respect to optical stimulation time for multi-grain aliquots. This exploits the existence of traps within minerogenic dosimeters that bleach with different efficiency for a given wavelength of light to verify partial bleaching. D_e (t) plots (Fig. 6; Bailey *et al*., 2003) are constructed from separate integrals of signal decay as laboratory optical stimulation progresses. A statistically significant increase in natural D_e (t) is indicative of partial bleaching assuming three conditions are fulfilled. Firstly, that a statistically significant increase in D_e (t) is observed when partial bleaching is simulated within the laboratory. Secondly, that there is no significant rise in D_e (t) when full bleaching is simulated. Finally, there should be no significant augmentation in D_e (t) when zero dose is simulated. Where partial bleaching is detected, the age derived from the sample should be considered a maximum estimate only. However, the utility of signal analysis is strongly dependent upon a samples pre-burial experience of sunlight's spectrum and its residual to post-burial signal ratio. Given in the majority of cases, the spectral exposure history of a deposit is uncertain, the absence of an increase in natural D_e (t) does not necessarily testify to the absence of partial bleaching.

Where requested and feasible, the insensitivities of multi-grain single-aliquot signal analysis may be circumvented by inter-aliquot D_e distribution studies. This analysis uses aliquots of single sand grains to quantify inter-grain D_e distribution. At present, it is contended that asymmetric inter-grain D_e distributions are symptomatic of partial bleaching and/or pedoturbation (Murray *et al*., 1995; Olley *et al*., 1999; Olley *et al*., 2004; Bateman *et al*., 2003). For partial bleaching at least, it is further contended that the D_e acquired during burial is located in the minimum region of such ranges. The mean and breadth of this minimum region is the subject of current debate, as it is additionally influenced by heterogeneity in microdosimetry, variable inter-grain response to SAR and residual to post-burial signal ratios. Presently, the apposite measure of age is that defined by the D_e interval delimited by the minimum and central age models of Galbraith *et al*. (1999).

3.2.2 Pedoturbation

The accuracy of sedimentation ages can further be controlled by post-burial trans-strata grain movements forced by pedo- or cryoturbation. Berger (2003) contends pedogenesis prompts a reduction in the apparent sedimentation age of parent material through bioturbation and illuviation of younger material from above and/or by biological recycling and resetting of the datable signal of surface material. Berger (2003) proposes that the chronological products of this remobilisation are A-horizon age estimates reflecting the cessation of pedogenic activity, Bc/C-horizon ages delimiting the maximum age for the initiation of pedogenesis with estimates obtained from Bt-horizons providing an intermediate age 'close to the age of cessation of soil development'. Singhvi et al. (2001), in contrast, suggest that B and C-horizons closely approximate the age of the parent material, the A-horizon, that of the 'soil forming episode'. At present there is no post-sampling mechanism for the direct detection of and correction for post-burial sediment remobilisation. However, intervals of palaeosol evolution can be delimited by a maximum age derived from parent material and a minimum age obtained from a unit overlying the palaeosol. Inaccuracy forced by cryoturbation may be bidirectional, heaving older material upwards or drawing younger material downwards into the level to be dated. Cryogenic deformation of matrix-supported material is, typically, visible; sampling of such cryogenically-disturbed sediments can be avoided.

4.0 Acquisition and accuracy of D_r value

Lithogenic D_r values were defined through measurement of U, Th and K radionuclide concentration and conversion of these quantities into β and γ D_r values (Table 1). β contributions were estimated from sub-samples by laboratory-based γ spectrometry using an Ortec GEM-S high purity Ge coaxial detector system, calibrated using certified reference materials supplied by CANMET. γ dose rates can be estimated from *in situ* NaI gamma spectrometry or, where direct measurements are unavailable as in the present case, from laboratory-based Ge γ spectrometry. *In situ* measurements reduce uncertainty relating to potential heterogeneity in the γ dose field surrounding each sample. The level of U disequilibrium was estimated by laboratory-based Ge γ spectrometry. Estimates of radionuclide concentration were converted into D_r values (Adamiec and Aitken, 1998), accounting for D_r modulation forced by grain size (Mejdahl, 1979) and present moisture content (Zimmerman, 1971). Cosmogenic D_r values were calculated on the basis of sample depth, geographical position and matrix density (Prescott and Hutton, 1994).

The spatiotemporal validity of D_r values can be considered a function of five variables. Firstly, age estimates devoid of *in situ* γ spectrometry data should be accepted tentatively if the sampled unit is heterogeneous in texture or if the sample is located within 300 mm of strata consisting of differing texture and/or mineralogy. However, where samples are obtained throughout a vertical profile, consistent values of γ D_r based solely on laboratory measurements may evidence the homogeneity of the γ field and hence accuracy of γ D_r values. Secondly, disequilibrium can force temporal instability in U and Th emissions. The impact of this infrequent phenomenon (Olley et al., 1996) upon age estimates is usually insignificant given their associated margins of error. However, for samples where this effect is pronounced (>50% disequilibrium between ^{238}U and ^{226}Ra; Fig. 7), the resulting age estimates should be accepted tentatively. Thirdly, pedogenically-induced variations in matrix composition of B and C-horizons, such as radionuclide and/or mineral remobilisation, may alter the rate of energy emission and/or absorption. If D_r is invariant through a dated profile and samples encompass primary parent material, then element mobility is likely limited in effect. Fourthly, spatiotemporal detractions from present moisture content are difficult to assess directly, requiring knowledge of the magnitude and timing of differing contents. However, the maximum influence of moisture content variations can be delimited by recalculating D_r for minimum (zero) and maximum (saturation) content. Finally, temporal alteration in the thickness of overburden alters cosmic D_r values. Cosmic D_r often forms a negligible portion of total D_r. It is possible to quantify the maximum influence of overburden flux by recalculating D_r for minimum (zero) and maximum (surface sample) cosmic D_r.

5.0 Estimation of Age

Ages reported in Table 1 provide an estimate of sediment burial period based on mean D_e and D_r values and their associated analytical uncertainties. Uncertainty in age estimates is reported as a product of systematic and experimental errors, with the magnitude of experimental errors alone shown in parenthesis (Table 1). Probability distributions indicate the inter-aliquot variability in age (Fig. 8). The maximum influence of temporal variations in D_r forced by minima-maxima in moisture content and overburden thickness is illustrated in Fig. 8. Where uncertainty in these parameters exists this age range may prove instructive, however the combined extremes represented should not be construed as preferred age estimates. The analytical validity of each sample is presented in Table 2.

6.0 Analytical uncertainty

All errors are based upon analytical uncertainty and quoted at 1σ confidence. Error calculations account for the propagation of systematic and/or experimental (random) errors associated with D_e and D_r values.

For D_e values, systematic errors are confined to laboratory β source calibration. Uncertainty in this respect is that combined from the delivery of the calibrating γ dose (1.2%; NPL, pers. comm.), the conversion of this dose for SiO_2 using the respective mass energy-absorption coefficient (2%; Hubbell, 1982) and experimental error, totalling 3.5%. Mass attenuation and bremsstrahlung losses during γ dose delivery are considered negligible. Experimental errors relate to D_e interpolation using sensitisation corrected dose responses. Natural and regenerated sensitisation corrected dose points (S_i) were quantified by,

$$S_i = (D_i - x.L_i) / (d_i - x.L_i) \qquad \textbf{Eq.1}$$

where D_i = Natural or regenerated OSL, initial 0.2 s

L_i = Background natural or regenerated OSL, final 5 s

d_i = Test dose OSL, initial 0.2 s

x = Scaling factor, 0.08

The error on each signal parameter is based on counting statistics, reflected by the square-root of measured values. The propagation of these errors within Eq. 1 generating σS_i follows the general formula given in Eq. 2. σS_i were then used to define fitting and interpolation errors within exponential plus linear regressions.

For D_r values, systematic errors accommodate uncertainty in radionuclide conversion factors (5%), β attenuation coefficients (5%), a-value (4%; derived from a systematic α source uncertainty of 3.5% and experimental error), matrix density (0.20 $g.cm^{-3}$), vertical thickness of sampled section (specific to sample collection device), saturation moisture content (3%), moisture content attenuation (2%), burial moisture content (25% relative, unless direct evidence exists of the magnitude and period of differing content) and NaI gamma spectrometer calibration (3%). Experimental errors are associated with radionuclide quantification for each sample by NaI and Ge gamma spectrometry.

The propagation of these errors through to age calculation was quantified using the expression,

$$\sigma y\ (\delta y/\delta x) = (\Sigma\ ((\delta y/\delta x_n).\sigma x_n)^2)^{1/2} \qquad \textbf{Eq. 2}$$

where y is a value equivalent to that function comprising terms x_n and where σy and σx_n are associated uncertainties.

Errors on age estimates are presented as combined systematic and experimental errors and experimental errors alone. The former (combined) error should be considered when comparing luminescence ages herein with independent chronometric controls. The latter assumes systematic errors are common to luminescence age estimates generated by means identical to those detailed herein and enable direct comparison with those estimates.

Fig. 1 Signal Calibration

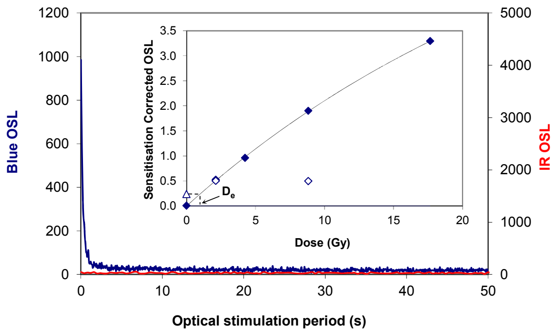


Fig. 1 Signal Calibration Natural blue and laboratory-induced infrared (IR) OSL signals. Detectable IR signal decays are diagnostic of feldspar contamination. Inset, the natural blue OSL signal (open triangle) of each aliquot is calibrated against known laboratory doses to yield equivalent dose (D_e) values. Repeats of low and high doses (open diamonds) illustrate the success of sensitivity correction.

Fig. 2 Dose Recovery The acquisition of D_e values is necessarily predicated upon thermal treatment of aliquots succeeding environmental and laboratory irradiation. The Dose Recovery test quantifies the combined effects of thermal transfer and sensitisation on the natural signal using a precise lab dose to simulate natural dose. Based on this an appropriate thermal treatment is selected to generate the final D_e value.

Fig. 3 Inter-aliquot D_e distribution Provides a measure of inter-aliquot statistical concordance in D_e values derived from **natural** irradiation. Discordant data (those points lying beyond **±2 standardised ln D_e**) reflects heterogeneous dose absorption and/or inaccuracies in calibration.

Fig. 4 Low and High Repeat Regenerative-doses Measures the statistical concordance of D_e from **low** and **high** repeat regenerative-doses with the applied regenerative-dose. Discordant data (those points lying beyond ±2 ln D_e standardised against the applied regenerative-dose) indicate a significant impact of uncorrected sensitisation upon dose response and D_e interpolation.

Fig. 5 OSL to Post-IR OSL Measures the statistical concordance of post-IR OSL D_e with the applied regenerative-dose. Discordant, underestimating data (those points lying below -2 ln D_e standardised against the applied regenerative-dose) coupled with an IRSL signal (Fig. 1) highlight the presence of significant feldspar contamination.

Fig. 6 Signal Analysis Statistically significant increase in **natural** D_e value with signal stimulation period is indicative of a partially-bleached signal, provided a significant increase in D_e results from **simulated partial bleaching** followed by insignificant adjustment in D_e for simulated **zero** and **full bleach** conditions. Ages from such samples are considered maximum estimates. In the absence of a significant rise in D_e with stimulation time, simulated partial bleaching and zero/full bleach tests are not assessed.

Fig. 7 U Activity Statistical concordance (equilibrium) in the activities of the daughter radioisotope ^{226}Ra with its parent ^{238}U may signify the temporal stability of D_r emissions from these chains. Significant differences (disequilibrium; >50%) in activity indicate addition or removal of isotopes creating a time-dependent shift in D_r values and increased uncertainty in the accuracy of age estimates. A 20% disequilibrium marker is also shown.

Fig. 8 Age Range The **mean age range** provides an estimate of sediment burial period based on mean D_e and D_r values with associated analytical uncertainties. The probability distribution indicates the inter-aliquot variability in age. The **maximum influence** of temporal variations in D_r forced by minima-maxima variation in moisture content and overburden thickness may prove instructive where there is uncertainty in these parameters, however the combined extremes represented should not be construed as preferred age estimates.

Fig. 2 Dose Recovery

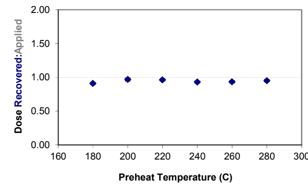


Fig. 3 Inter-aliquot D_e distribution

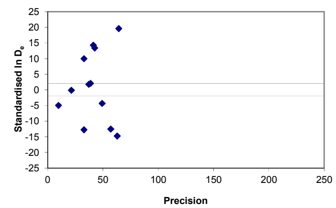


Fig. 4 Low and High Repeat Regenerative-doses

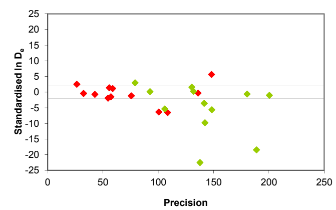
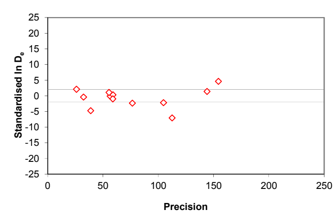


Fig. 5 Post-IR OSL



Sample: GL15079

Fig. 6 Signal Analysis

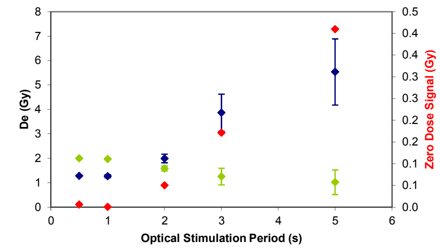


Fig. 7 U Decay Activity

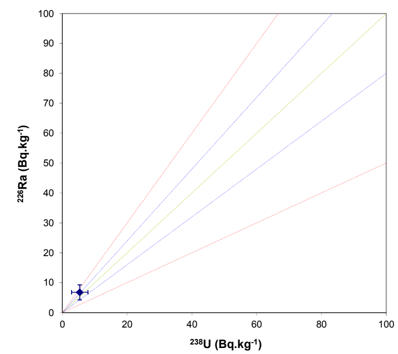


Fig. 8 Age Range

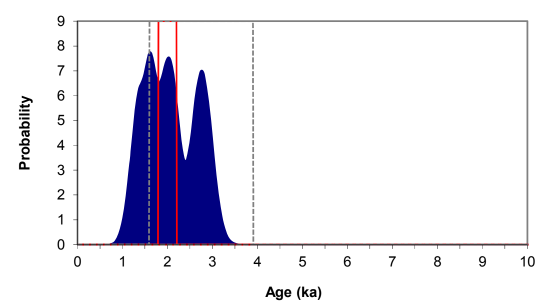


Fig. 1 Signal Calibration

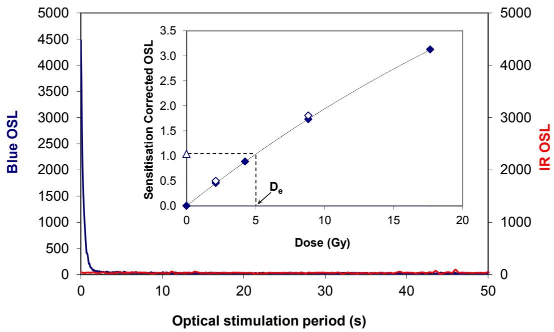


Fig. 2 Dose Recovery

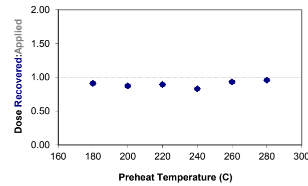


Fig. 6 Signal Analysis

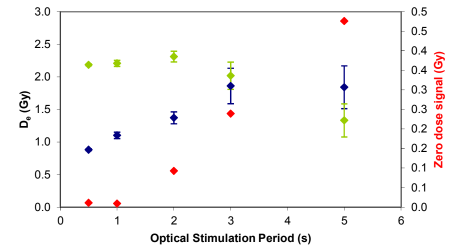


Fig. 3 Inter-aliquot D_e distribution

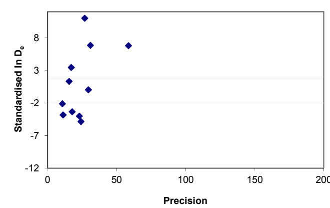


Fig. 7 U Decay Activity

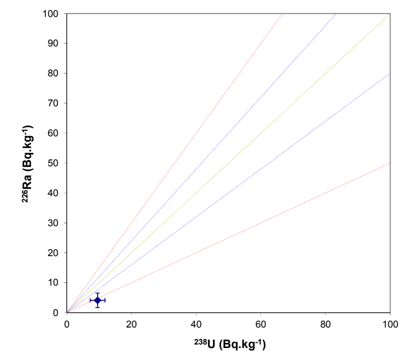


Fig. 4 Low and High Repeat Regenerative-doses

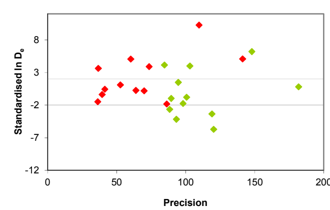


Fig. 5 Post-IR OSL

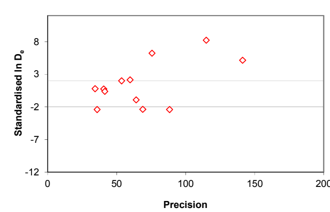
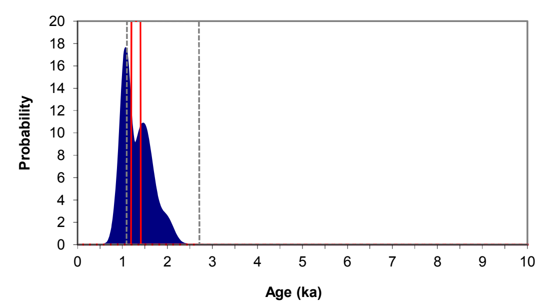


Fig. 8 Age Range



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Sample: GL15080

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Appendix 2. Context List

Context Number	Feature Number	Feature Type	Category	Description	Width	Depth	Over	Under	Cut by	Cuts
0001	0001	Ditch	Cut	Linear in plan, aligned E-W with a bowl shape profile, concave sides and a concave base.	1m	0.44m		0002		
0002	0001	Ditch	Fill	Dark grey brown loose sand, no clear inclusions.	1m	0.44m	0001	0004		
0003	0003	Ditch	Cut	Linear in plan, aligned E-W with sloped sides and a concave base.	3m	0.4-1.1m		0017		0012
0004	0003	Ditch	Fill	Mid grey brown soft silty sand with occasional small flint inclusions, diffuse clarity.	3m	0.4-1.1m	0017, 0002		0014	
0005	0005	Ditch	Cut	Linear ditch aligned E-W with concave sides and a concave base.	0.7m	0.18m		0006		
0006	0005	Ditch	Fill	Light grey soft sand with frequent small and large flint inclusions. Clear clarity.	0.7m	0.18m	0005		0007	
0007	0007	Ditch	Cut	Linear ditch aligned E-W with an unclear profile, unclear sides and a flat base.	1.8m	0.24m		0008		0010, 0006
0008	0007	Ditch	Fill	Mixed mid grey, mid brown and mid orange loose sand with no inclusions, diffuse clarity.	1.8m	0.24m	0007		0011	
0009	0009	Ditch	Cut	Linear ditch aligned E-W with a bowl shape profile, concave sides and a concave base.	0.74m	0.18m		0010		
0010	0009	Ditch	Fill	Light grey loose sand with moderate large and small flint inclusions. Clear clarity.	0.74m	0.18m	0009		0007	
0011	0011	Ditch	Cut	Ditch aligned E-W with a bowl shaped profile, irregular concave sides and a flat base.	3.82m	0.96m		0012		0016, 0008
0012	0011	Ditch	Fill	Mottled red-brown and mid grey sharp sand with occasional small flint inclusions.	3.82m	0.96m	0011		0003, 0013	
0013	0013	Ditch	Cut	Linear ditch aligned E-W with a bowl shaped profile, concave sides and a concave base.	0.54m	0.24m		0014		0012
0014	0013	Ditch	Fill	Mid grey brown and mottled red brown soft sand with occasional small rounded flint pebbles.	0.54m	0.24m	0013			
0015	0015	Ditch	Cut	Linear ditch aligned E-W with an unclear profile, concave base and irregular concave side.	1.5m	0.7m		0016		
0016	0015	Ditch	Fill	Pale grey soft fine sand with occasional iron pan. Clear clarity.	1.5m	0.7m	0015		0011	
0017	0003	Ditch	Fill	Light orange grey loose sand with no visible inclusions. Diffuse clarity. Possible slump fill in ditch 0003.	1.14m	0.18m	0003	0004		

Appendix 3. OASIS form

OASIS ID: suffolka1-224698

Project details	
Project name	Land off Fengate Drove, Brandon
Short description of the project	An excavation to further investigate the known but hitherto undated Norfolk/Suffolk county boundary ditch was carried out in October 2015, with a view to collecting suitable sample material for Optical Spin Luminescence analysis and dating. The excavation of a new cross-section across the boundary revealed a similar profile to that seen in previous fieldwork, with a sequence of ditch cuts showing a boundary slightly shifting over time towards the north. The lack of a finds assemblage continues to suggest that the boundary is not immediately associated with any area of settlement and it is still assumed that later deposits in the stratigraphic sequence are of a medieval or post-medieval date, the boundary surviving as a tree/ fence line in the late 19th century. A date for the origin of the boundary is still uncertain, despite the acquisition of two dates from Optical Spin Luminescence analysis of two separate samples. A tentative Anglo-Saxon date of 615 to 815 AD has been given for one of the earlier fills in the stratigraphic sequence but the validity of this result is dubious, it being stratigraphically contradictory to the second result which implies that neither date can be relied upon.
Project dates	Start: 19-10-2015 End: 19-10-2015
Previous/future work	Yes / No
Any associated project reference codes	BRD 189 - Sitecode
Any associated project reference codes	DC/14/2219 - Planning Application No.
Type of project	Recording project
Current Land use	Vacant Land 3 - Despoiled land (contaminated derelict and ?brownfield? sites)
Monument type	DITCH Uncertain
Significant Finds	N/A None
Investigation type	"Open-area excavation"
Prompt	National Planning Policy Framework - NPPF
Project location	
Country	England
Site location	SUFFOLK FOREST HEATH BRANDON Land off Fengate Drove, Brandon
Study area	60 Square metres
Site coordinates	TL 7823 8728 52.453920460617 0.623295341306 52 27 14 N 000 37 23 E Point
Height OD / Depth	Min: 4m Max: 6m
Project creators	
Name of Organisation	Suffolk Archaeology CIC
Project brief originator	Local Authority Archaeologist and/or Planning Authority/advisory body
Project design originator	Suffolk Archaeology CIC
Project director/manager	John Craven

Project supervisor	Michael Green
Type of sponsor/funding body	Developer
Name of sponsor/funding body	Allenbuild Ltd
Project archives	
Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Contents	"none"
Digital Media available	"Database","GIS","Images raster / digital photography","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"none"
Paper Media available	"Context sheet","Plan","Report","Section"
Project bibliography 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Land off Fengate Drove, Brandon, Suffolk
Author(s)/Editor(s)	Green, M. and Craven, J.
Other bibliographic details	Suffolk Archaeology CIC Report No. 2015/076
Date	2016
Issuer or publisher	Suffolk Archaeology CIC
Place of issue or publication	Needham Market, Suffolk
Description	SACIC excavation archive report

Appendix 4. WSI

SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Land off Fengate Drove

Brandon, Suffolk

Client:
Allenbuild Ltd

Date:
September 2015

BRD 189
Written Scheme of Investigation and Risk Assessment – Archaeological Excavation
Author: John Craven
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Project details

Planning Application No:	DC/14/2219
Curatorial Officer:	Dr Richard Hoggett (Suffolk County Council Archaeological Service)
Grid Reference:	TL 78238728
Area:	1.47ha
HER Event No/Site Code:	BRD 189/ESF23245
Oasis Reference:	224698
Project Start date	c.19th October 2015
Project Duration:	c. 2 days
Client/Funding Body:	Allenbuild Ltd
SACIC Project Manager	John Craven
SACIC Project Officer:	Michael Green
SACIC Job Code:	BRDFEN001

1. Introduction

- A program of archaeological excavation is required to further investigate known archaeological deposits on the proposed site of residential development at Fengate Drove, Brandon, Suffolk (Fig. 1). The work is required by a condition on planning application CD/14/2219, in accordance with paragraph 141of the National Planning Policy Framework.
- The work required is detailed in a Brief (dated 02/04/2015), produced by the archaeological adviser to the Local Planning Authority (LPA), Dr Richard Hoggett of Suffolk County Council Archaeological Service (SCCAS). The Brief specifies a new stage of excavation of the county boundary ditch, with a view to collecting suitable sample material so that the feature can scientifically dated.
- Suffolk Archaeology CIC (SACIC) has been contracted to carry out the project. This document details how the requirements of the Brief and general SCCAS guidelines (SCCAS 2012) will be met, and has been submitted to SCCAS for approval on behalf of the LPA. It provides the basis for measurable standards and will be adhered to in full, unless otherwise agreed with SCCAS.
- It should be noted that, following the excavation fieldwork, the assessment report will establish the further analysis required to publish the site in an updated project design (UPD). If approved by SCCAS the work outlined in the UPD will need to be completed to allow final discharge of planning conditions. The client is advised to consult with SCCAS as to their obligations following receipt of the excavation assessment report.

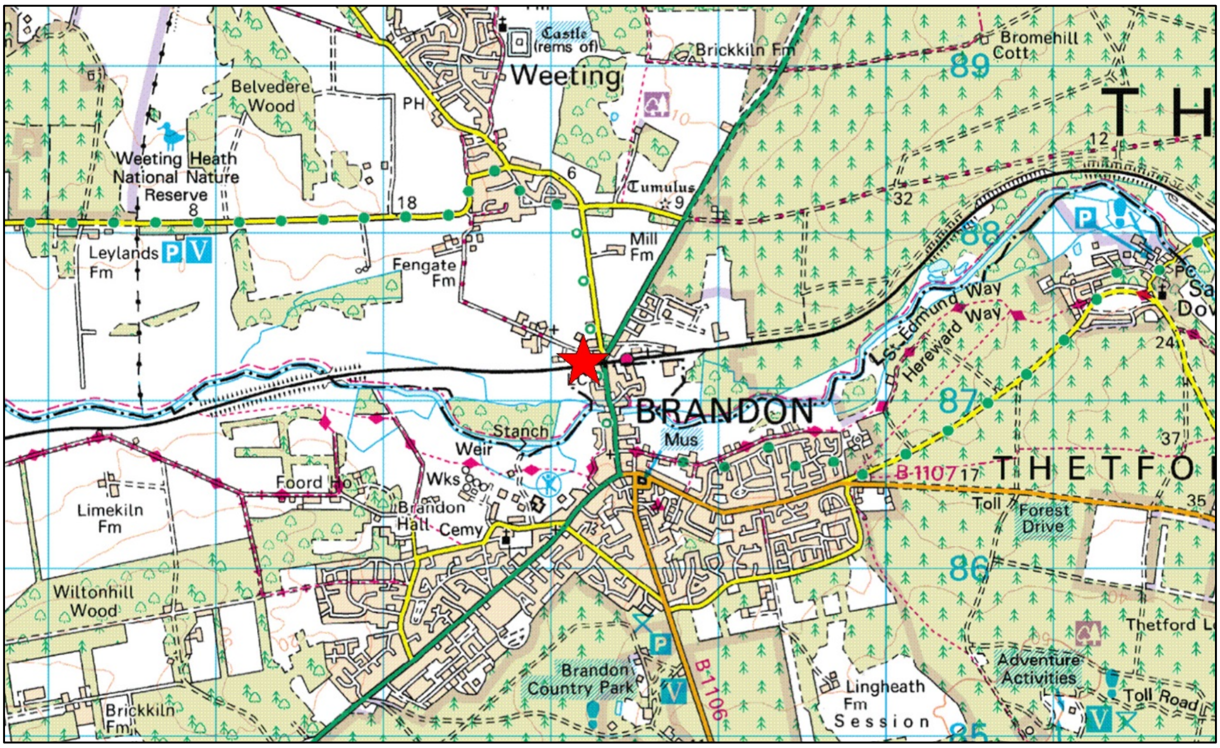
2. The Site

- The site, an area of *c.*1.47ha, consists of a former timberyard lying between Fengate Drove and the railway line (Fig. 1). At this point the county boundary between Norfolk and Suffolk, which generally follows the course of the river, encloses a small area on the north bank as within Suffolk.
- The site lies at a height of *c.*5-6m above Ordnance datum, on the northern edge of the Little Ouse floodplain, with the river being 280m to the south.

- The site geology consists of superficial river terrace deposits of sands and gravels, which overlie chalk bedrock of the Holywell Nodular Chalk Formation and New Pit Chalk Formation (British Geological Survey website).

3. Archaeological and historical background

- The site was initially deemed of interest by SCCAS during an earlier planning application in 2005, due to its location within 300m of the lowest known early medieval crossing across the river, its high potential for showing evidence of settlement from the Saxon or medieval periods and the fact that the county boundary crossed the site.
- Trial trench evaluation (Craven 2005) subsequently confirmed the presence of a substantial ditch on the county boundary but due to the depths of trenches was not fully investigated. A subsequent program of archaeological excavation was then carried out with the aim of establishing the nature and size of the ditch, and the date of its infilling and abandonment (Craven 2006). This showed that the boundary ditch had apparently been infilled and recut at least three times, with its position gradually shifting to the north. Although the county boundary and its ditch are presumed to have originated in the Late Saxon-Early medieval period this remained unconfirmed as, despite the size of the ditch and its apparent prolonged use, there was very little artefactual material recovered. The finds consisted of a single pottery sherd of 15th/16th century date in an early deposit, a fragment of 15th century brick and a small collection of late medieval/post-medieval material indicating a possible final infilling and abandonment of the ditch in the late medieval/post-medieval periods.
- SCCAS/CT has therefore requested that the ditch be further investigated prior to development, the priority of the work to be obtaining a scientific date for the feature.



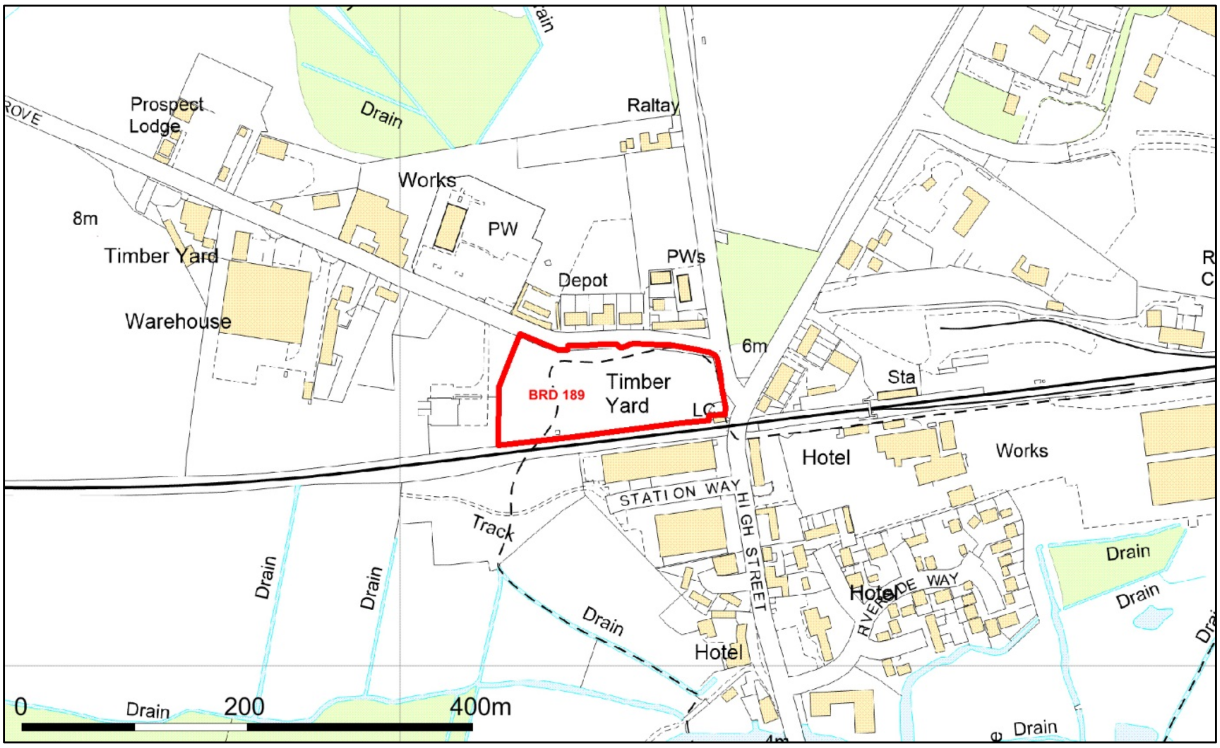


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Figure 1. Location map

4. Project Objectives

- The aim of the project is to further investigate the county boundary ditch, with a view to confirming a date for its construction, prior to the development of the site. The project will create a full site archive and accompanying assessment report and, if warranted, a publication text.

- The project will:

    - Excavate and record all archaeological deposits present in the excavation area.
    - Produce a full site archive.
    - Produce a post-excavation assessment report that presents the results of excavation fieldwork and assesses its research potential (see below).
    - Provide an updated project design, timetable and costing, for completing further analysis of the site archive and preparing a publication text.
    - Publish the site, if appropriate, in a recognised archaeological journal or monograph.
    - Deposit the project archive in a suitable store.

- Depending on the results of the scientific dating the project may have potential to address research aims concerning Anglo-Saxon and medieval rural occupation, as defined in the Regional Research Framework for the Eastern Counties (Brown and Glazebrook 2000, Medlycott 2011). Analysis of the site archive may be able to contribute towards topics such as our understanding of the origins and development of Anglo-Saxon/medieval settlement in the region.

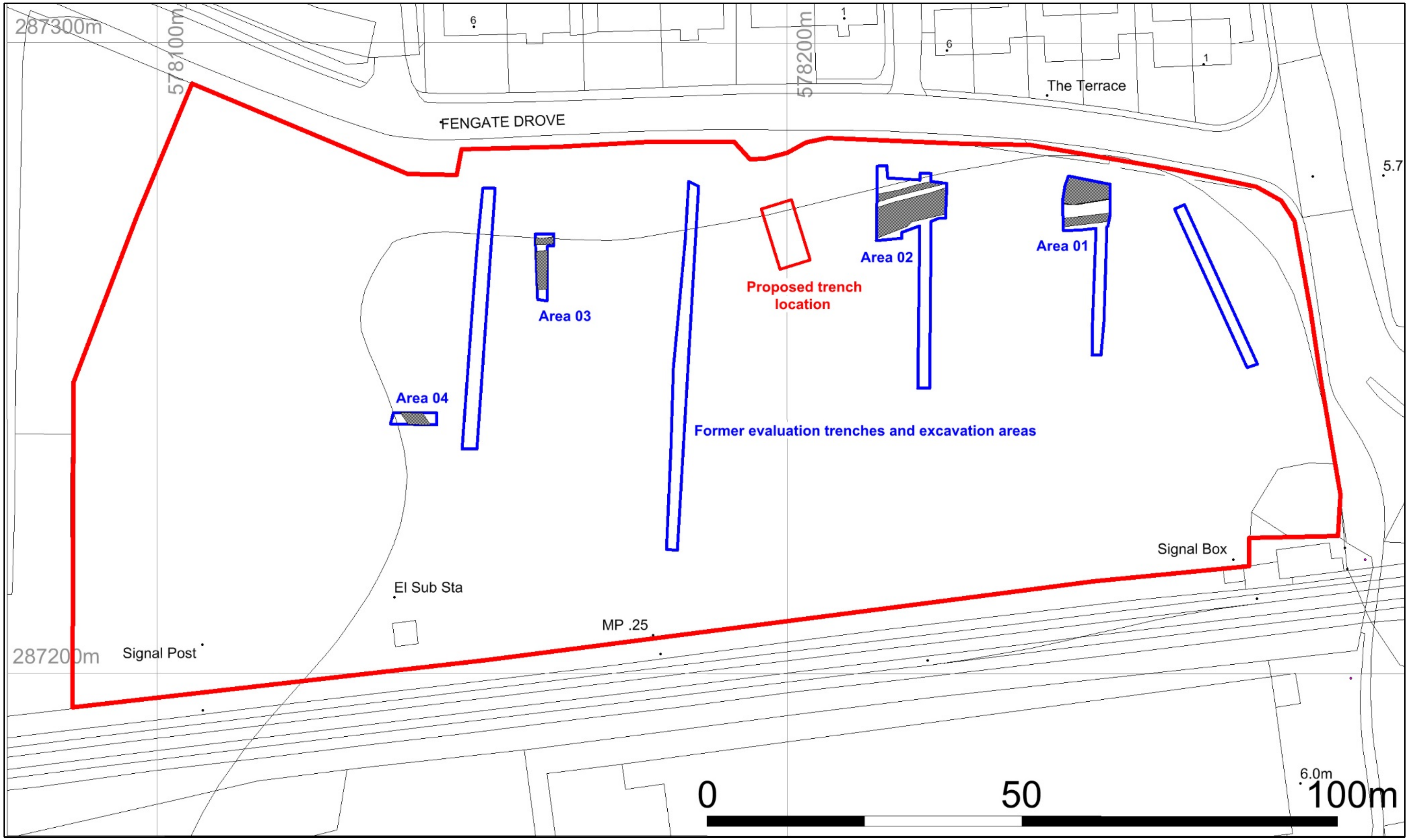

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Figure 2. Excavation area plan

5. Archaeological method statement

5.1. Management

- The project will be managed by SACIC Project Officer John Craven in accordance with the principles of *Management of Research in the Historic Environment* (MoRPHE, Historic England 2015).
- SCCAS will be given ten days' notice of the commencement of the fieldwork and arrangements will be made for SCCAS visits to enable the works to be monitored effectively.
- Full details of project staff, including sub-contractors and specialists are given in section 6 below.

5.2. Project preparation

- The project will continue to use site code BRD 189 and a new event number has been obtained from the SCCAS HER Officer and will be included on all future project documentation.
- An OASIS online record has been initiated and key fields in details, location and creator forms have been completed.
- A pre-site inspection and Risk Assessment for the project has been completed.

5.3. Fieldwork

- Fieldwork standards will be guided by 'Standards for Field Archaeology in the East of England', EAA Occasional Papers 14, and the Chartered Institute For Archaeology's (CIFA) paper 'Standard and Guidance for archaeological field excavation', revised 2014.
- The archaeological fieldwork will be carried out by members of SACIC led by Project Officer Michael Green. The fieldwork team will be drawn from a pool of suitable staff at SACIC and will include an experienced metal detectorist.
- Following discussion with Dr Hoggett the project will excavate a new full cross-

section of the ditch. To allow for the full identification of the ditch and its recuts it is anticipated that a 10m long trench will be required, and that this may need to be 4-5m wide at groundlevel to allow for the stepping of trench sides part way down so that the base of the feature (at c.2m below groundlevel) can be hand-excavated. As with the previous excavation Area 02 it is anticipated that the upper levels of the ditch will be removed by machine, until its cut can be identified against the natural subsoil (previously a depth of c.1.3m).

- The proposed excavation location for the trench (Fig. 2) is based upon both the previous fieldwork and the location of the proposed residential units. It will be marked out using an RTK GPS system. If necessary the position of the trench will be shifted to respect any previously unknown buried services, areas of disturbance or contamination, or any other obstacles which may prevent the ability of the trench to obtain a complete/intact ditch cross-section.
- The ditch cross-section will be excavated using a machine equipped with a back-acting arm and toothless ditching bucket (measuring at least 1.8m wide), under the supervision of an archaeologist. This will involve the removal of an estimated 0.5m of topsoil and 0.8m of mixed waterlain sands or modern deposits and subsoils until the cut of the ditch is clearly defined.
- Spoilheaps will be created adjacent to the site and topsoil and subsoil will be kept separate if required. Spoilheaps will be examined and metal-detected for archaeological material.
- The excavation of archaeological deposits will be by hand, including stratified layers, unless it can be demonstrated to the satisfaction of SCCAS that no information will be lost by using a machine. All features will be excavated by hand unless otherwise agreed with SCCAS. Typically 50% of discrete features such as pits and a minimum of 10% of linear features (in 1m slots) will be sampled by hand excavation, but this will be increased if needed to allow informed interpretation of their date and function.
- Metal detector searches will take place throughout the excavation by an experienced SACIC metal-detectorist.
- The depth and nature of colluvial or other masking deposits across the site will be recorded.

Sampling

- The proposed excavation sampling strategy will aim to recover suitable material for Optical Spin Luminescence (OSL) dating, to meet the primary aim of the project to date the ditch.
- Samples for OSL dating will be collected in accordance with advice provided by Dr P. S. Toms, School of Natural and Social Sciences, University of Gloucestershire, to whom the samples are to be sent for analysis.
- Once the cross-section of the ditch is completed and recorded a decision will be made as to which contexts to sample. The primary aim will be to sample the basal fills of each defined cut or re-cut.
- All samples will be positioned at least 0.3m below the existing ground surface and if possible will be 0.3m below any upper stratigraphic contact. If within 0.3m of an upper stratigraphic contact the sample will be collected from the base of the deposit to be dated. Collected samples will consist of either sand (~90-250 microns) or fine silt (~5-15 microns).
- The section will be cleaned until a surface whose moisture content has not been affected by surface drying is exposed. A 0.2m column sample will then be collected using 40mm diameter black uPVC drainpipe (which will minimise light exposure) and wrapped in clingfilm.
- After extracting the main dating sample a minimum of 100 g of sediment surrounding it, (lying roughly within a circle ~300 mm in radius) will be collected and double bagged.
- The position of each column will be recorded on the site plan and on a drawn section of the trench profile. Full data regarding position and height of each sample, and the thickness/composition of the section's stratigraphic units will accompany the samples when sent for analysis.
- Previous work has indicated that it is unlikely that there will be any waterlogged deposits, or natural environmental evidence such as palaeochannels, alluvial or colluvial sequences. If necessary, for example if waterlogged deposits are encountered, then advice will be sought from the Historic England Science Advisor for the East of England on the need for specialist environmental techniques such as coring or column sampling.

Site recording

- An overall site plan showing feature positions, sections and levels will be made using an RTK GPS or Total Station Theodolite. Individual detailed trench or feature plans etc will be recorded by hand at 1:10, 1:20 or 1:50 as appropriate to complexity. All excavated sections will be recorded at a scale of 1:10 or 1:20, also as appropriate to complexity. All such drawings will be in pencil on A3 pro forma gridded permatrace sheets. All levels will refer to Ordnance Datum. Section and plan drawing registers will be maintained.
- The site, and all archaeological features and deposits will be recorded using standard pro forma SACIC registers and recording sheets and numbering systems. Record keeping will be consistent with the requirements of the Suffolk HER and will be compatible with its archive.
- A photographic record, consisting of high resolution digital images, will be made throughout the. A number board displaying site code and, if appropriate, context number and a metric scale will be clearly visible in all photographs. A photographic register will be maintained.
- All pre-modern finds will be kept and no discard policy will be considered until all the finds have been processed and assessed. Finds on site will be treated following appropriate guidelines (Watkinson & Neal 2001) and a conservator will be available for on-site consultation as required.
- All finds will be brought back to the SACIC finds department at the end of each day for processing, quantifying, packing and, where necessary, preliminary conservation. Finds will be processed and receive an initial assessment during the fieldwork phase and this information will be fed back to site to inform the on-site excavation methodology.
- If human remains are encountered guidelines from the Ministry of Justice will be followed. Human remains will be treated at all stages with care and respect, and will be dealt with in accordance with the law and the provisons of Section 25 of the Burial Act 1857. The evaluation will attempt to establish the extent, depth and date of burials whilst leaving remains in situ. If human remains are to be lifted, for instance if analysis is required to fully evaluate the site, then a Ministry of Justice license for their removal will be obtained in advance. In such cases appropriate

guidance (McKinley & Roberts 1993, Brickley & McKinley 2004) will be followed and, on completion of full recording and analysis, the remains, where appropriate, will be reburied or kept as part of the project archive.

- In the event of unexpected or significant deposits being encountered on site, the client and SCCAS will be informed. Such circumstances may necessitate changes to the Brief and hence excavation methodology, in which case a new archaeological quotation will have to be agreed with the client, to allow for the recording of said unexpected deposits. If the excavation is aborted, i.e. because unexpected deposits have made the development unviable or led to other mitigation measures such as project redesign, then all exposed archaeological features will be recorded as usual prior to completion of fieldwork and a PXA report produced.
- Fieldwork will not end without the prior approval of SCCAS. On completion the site will be handed over to the client, to either backfill or begin development.

Outreach

- Due to the small size and likely short duration of the project outreach activities such as an open day or tours for the general public, local schools, councillors, societies etc, will not be viable.
- The Suffolk Archaeology website is currently under construction but, if live by the time of the excavation, updates as to the excavations progress may be made publically available. This may include short statements as to the nature of any archaeological discoveries accompanied by photographs or videos. Suffolk Archaeology also has a Facebook page (www.facebook.com/SuffolkArchCIC) and Twitter account (@SuffolkArchCIC) on which updates can be issued.
- SACIC staff are also available for talks and lectures to local groups and societies on request, and the project results could be incorporated into such presentations at a later date.
- SACIC also has a dedicated Outreach Officer who can provide activities for KS 2 and 3 classes, or other classes/ages upon discussion.

5.4. Post-excavation assessment

- The post-excavation finds work will be managed by the SACIC Finds Team Manager, Richenda Goffin, with the overall post-excavation managed by John Craven. Specialist finds staff, whether internal SACIC personnel or external specialists, are experienced in local and regional types and periods for their field.
- All finds will be processed and marked (HER site code and context number) following ICON guidelines and the requirements of the Suffolk HER. For the duration of the project all finds will be stored according to their material requirements in the SACIC stores at Needham Market, Suffolk. Metal finds will be stored in accordance with ICON) guidelines, *initially recorded and assessed for significance* before dispatch to a conservation laboratory within 4 weeks of the end of the excavation. All pre-modern silver, copper alloy and ferrous metal artefacts and coins will be x-rayed if necessary for identification. Sensitive finds will be conserved if necessary and deposited in bags/boxes suitable for long term storage to ICON standards. All coins will be identified to a standard acceptable to normal numismatic research.
- All on-site derived site data will be entered onto a digital (Microsoft Access) SACIC database.
- Bulk finds will be fully quantified and the subsequent data will be added to the digital site database. Finds quantification will fully cover weights and numbers of finds by context and will include a clear statement for specialists on the degree of apparent residuality observed.
- Assessment reports for all categories of collected bulk finds will be prepared in-house or commissioned as necessary and will meet appropriate regional or national standards. Specialist reports will include sufficient detail and tabulation by context of data to allow assessment of potential for analysis and will include non-technical summaries.
- All hand drawn site plans and sections will be scanned.
- All raw data from GPS or TST surveys will be uploaded to the project folder, suitably labelled and kept as part of the project archive.
- Selected plan drawings will then be digitised as appropriate for combination with the results of digital site survey to produce a full site plan, compatible with MapInfo

GIS software.

- Selected hand-drawn sections will be digitised using autocad software.

PXA Report

- A full post-excavation assessment report (PXA) will be produced, consistent with the principles of Management of Research in the Historic Environment (MoRPHE, Historic England 2015). If the fieldwork results do not warrant such an assessment and publication SCCAS will be asked to approve the production of a full grey literature archive report.
- The PXA report will include a suitable level of documentary research to set the results in their geographical, topographical, archaeological and historical context.
- The PXA report will contain a description of the project background, location plans, excavation methodology, a period by period description of results, finds assessments and a full inventory of finds and contexts. The report will also include scale plans, sections drawings, illustrations and photographic plates as required.
- The PXA will present a clear and concise assessment of the archaeological value and significance of the results, and identify the site's research potential in the context of the Regional Research Framework for the East of England (Brown and Glazebrook, 2000, Medlycott 2011). This will include an assessment of potential research aims that could be addressed by the site evidence.
- The PXA will include an Updated Project Design, with a timetable, for completing further analysis, the production of a full archive report and publication text, and the final deposition of the site archive.
- The report will include a summary in the established format for inclusion in the annual *'Archaeology in Suffolk'* section of the Proceedings of the Suffolk Institute of Archaeology and History.
- A copy of this Written Scheme of Investigation will be included as an appendix in the report.
- The report will include a copy of the completed project OASIS form as an appendix.

- An unbound draft copy of the report will be submitted to SCCAS for approval within 6 months of completion of fieldwork.

5.5. Final analysis, archive report and publication

- The PXA report will establish the work required, if any, to produce a suitable publication text. It will outline the nature and scope of the publication and the most appropriate journal for its submission. The nature of the project, and its specific focus of obtaining a scientific date for the boundary ditch, suggests that the most likely outcome will be the submission of an illustrated article for publication in the Proceedings of the Suffolk Institute of Archaeology and History. However depending on results other options may be available such as an article in the annual journal of the Medieval Settlement Research Group (*Medieval Settlement Research*), or the annual journal *Anglo-Saxon Studies in Archaeology and History* (School of Archaeology, Oxford University).

5.6. Project archive

- On completion and approval of each stage (the PXA report, archive report and publication text) a printed hard copy will be lodged with the Suffolk HER.
- PXA and archive reports will be uploaded to the OASIS website for online publication by the Archaeological Data Service. A digital and fully georeferenced vector plan showing the excavation area, compatible with MapInfo software, will also be uploaded.
- A second unbound copy of the report will be included with the project archive.
- A digital .pdf copy of each approved report will be supplied to the client. Printed and bound copies will be supplied to the client on request.
- The project archive, consisting of the complete artefactual assemblage, and all paper and digital records, will be deposited in the SCCAS Archaeological Store at Bury St Edmunds within 6 months of completion of fieldwork. The project archive will be consistent with MoRPHE (Historic England 2015) and ICON guidelines. The project archive will also meet the requirements of SCCAS (SCCAS 2010).
- The project costing includes a sum to meet SCCAS archive charges. A form

transferring ownership of the archive to SCCAS will be completed and included in the project archive.

- If the client, on completion of the project, does not agree to deposit the archive with, and transfer to, SCCAS, they will be expected to either nominate another suitable depository approved by SCCAS or provide as necessary for additional recording of the finds archive (such as photography and illustration) and analysis. A duplicate copy of the written archive in such circumstances would be deposited with the Suffolk HER.
- Exceptions from the deposition of the archive described above include:
  - Objects that qualify as Treasure, as detailed by the Treasure Act 1996. The client will be informed as soon as possible of any such objects are discovered/identified and the find will be reported to SCCAS and the Suffolk Finds Liaison Officer and hence the Coroner within 14 days of discovery or identification. Treasure objects will immediately be moved to secure storage at SCCAS and appropriate security measures will be taken on site if required. Any material which is eventually declared as Treasure by a Coroners Inquest will, if not acquired by a museum, be returned to the client and/or landowner. Employees of SCCAS, or volunteers etc present on site, will not eligible for any share of a treasure reward.
  - Other items of monetary value in which the landowner or client has expressed an interest. In these circumstances individual arrangements as to the curation and ownership of specific items will be negotiated. The client is aware that additional requirements may be made by SCCAS, such as for additional detailed recording and analysis, for items not submitted to the archive.
  - Human skeletal remains. The client/landowner by law will have no claim to ownership of human remains and any such will be stored by SACIC, in accordance with a Ministry of Justice licence, until a decision is reached upon their long term future, i.e. reburial or permanent storage.

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6. Project Staffing

6.1. Management

SACIC Manager	Dr Rhodri Gardner
SACIC Project Manager	John Craven
SACIC Finds Dept	Richenda Goffin

6.2. Fieldwork

The fieldwork team will be derived from the following pool of SACIC staff.

Name	Job Title	First Aid	Other skills/qualifications
Michael Green	Project Officer	Yes	Surveyor
Krisztina Baranyai	Project Assistant		
Preston Boyle	Project Assistant	Yes	
Tim Carter	Project Assistant	Yes	Metal detectorist
Hannah Cutler	Project Assistant		
Rebecca Smart	Project Assistant		
Stefania Usai	Project Assistant		

6.3. Post-excavation and report production

The production of the site report and submission of the project archive will be carried out by the fieldwork Project Officer. The post-excavation finds analysis will be managed by Richenda Goffin. The following SACIC specialist staff will contribute to the report as required.

Graphics and illustration	Ellie Cox, Gemma Bowen, Beata Wieczorek-Oleksy
Post Roman pottery and CBM	Richenda Goffin
Roman Pottery	Stephen Benfield
Environmental sample processing/assessment	Anna West
Finds quantification/assessment	Dr Ruth Beveridge
Finds Processing	Jonathan Van Jennians

SACIC also uses a range of external consultants for post-excavation analysis who will be sub-contracted as required. The most commonly used of these are listed below.

Sue Anderson	Human skeletal remains	Freelance
Sarah Bates	Lithics	Freelance
Julie Curl	Animal bone	Freelance
Anna Doherty	Prehistoric pottery	Archaeology South-East
Val Fryer	Plant macrofossils	Freelance
SUERC	Radiocarbon dating	Scottish Universities Environmental Research Centre
Cathy Tester	Roman pottery and general finds	Freelance
Donna Wreathall	Illustration	SCCAS

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