SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Land West of Church Road

Bentley, Suffolk

Client:
D. E. J. Baker, c/o Miss HV Adcock (CODE Development Planners)

Date:
January 2019

BTY 044
Geophysical Survey Report
SACIC Report No. 2018/019
Author: Timothy Schofield HND BSc MCIfA

Land West of Church Road
Bentley, Suffolk
BTY 044

Geophysical Survey Report

SACIC Report No. 2018/019

Author: Timothy Schofield

Illustrator: Timothy Schofield

Editor: Rhodri Gardner

Report Date: January 2019

HER Information

Site Code:	**BTY 044**
Site Name:	**Land West of Church Road, Bentley, Suffolk**
Report Number	**2018/019**
Planning Application No:	**Pre-determination**
Date of Fieldwork:	**8th – 9th February 2018**
Grid Reference:	**TM 1132 3709**
Oasis Reference:	**308207**
Curatorial Officer:	**Rachael Abrahams**
Project Officer:	**Timothy Schofield**
Client/Funding Body:	**D. E. J. Baker, c/o Miss HV Adcock (CODE Development Planners)**

Digital report submitted to Archaeological Data Service:
http://ads.ahds.ac.uk/catalogue/library/greylit

Disclaimer

Any opinions expressed in this report about the need for further archaeological work are those of Suffolk Archaeology CIC. 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 Archaeology CIC cannot accept responsibility for inconvenience caused to the clients should the Planning Authority take a different view to that expressed in the report.

Prepared By: Timothy Schofield
Date: January 2019

Approved By: Rhodri Gardner
Position: Director
Date: January 2019
Signed: R.V.Gardner.

Contents

List of Figures

List of Appendices

Summary

In February 2018 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land west of Church Road, Bentley, Suffolk. Two fields (a total of 2.7ha) were prospected for anomalies of an archaeological derivation, positioned over the proposed developments footprints. The western field was given over to cropped stubble and the eastern field was set-aside to scrubland.

The detailed fluxgate gradiometer survey prospected geophysical anomalies that are likely to be of a geological and agricultural derivation, along with those indicative of archaeological pits, agricultural ditches and geological variations.

1. Introduction

A detailed fluxgate gradiometer survey covering *c*. 2.7 hectares within two separate fields to the west of Church Road, Bentley, Suffolk (Fig.1) was undertaken by Suffolk Archaeology Community Interest Company (SACIC) on the 8th and 9th February 2018.

The geophysical survey was undertaken prior to determination of the planning application, in accordance with paragraph 128, 129 and 141 of the National Planning Policy Framework. Suffolk Archaeology CIC were commissioned to undertake the project by Helen Adcock of CODE Development Planners on behalf of D. E. J. Baker.

The “area of assessment” was chosen to understand the constraints and opportunities in the vicinity of the site submitted to Babergh District Council’s call for sites process during August 2016, to test the suitability of that site and its connections with the area opposite the primary school (possible school drop off/pick up area). Information from all technical disciplines has resulted in a revised site area, that will form the planning application boundary (Fig. 1). However, the proposed area for housing is smaller than that submitted in August 2016. Following receipt of the full constraints and opportunities from all disciplines of the project team, the site area that will form the basis of the planning application is shown as the site boundary (grey line) in Figure 1.

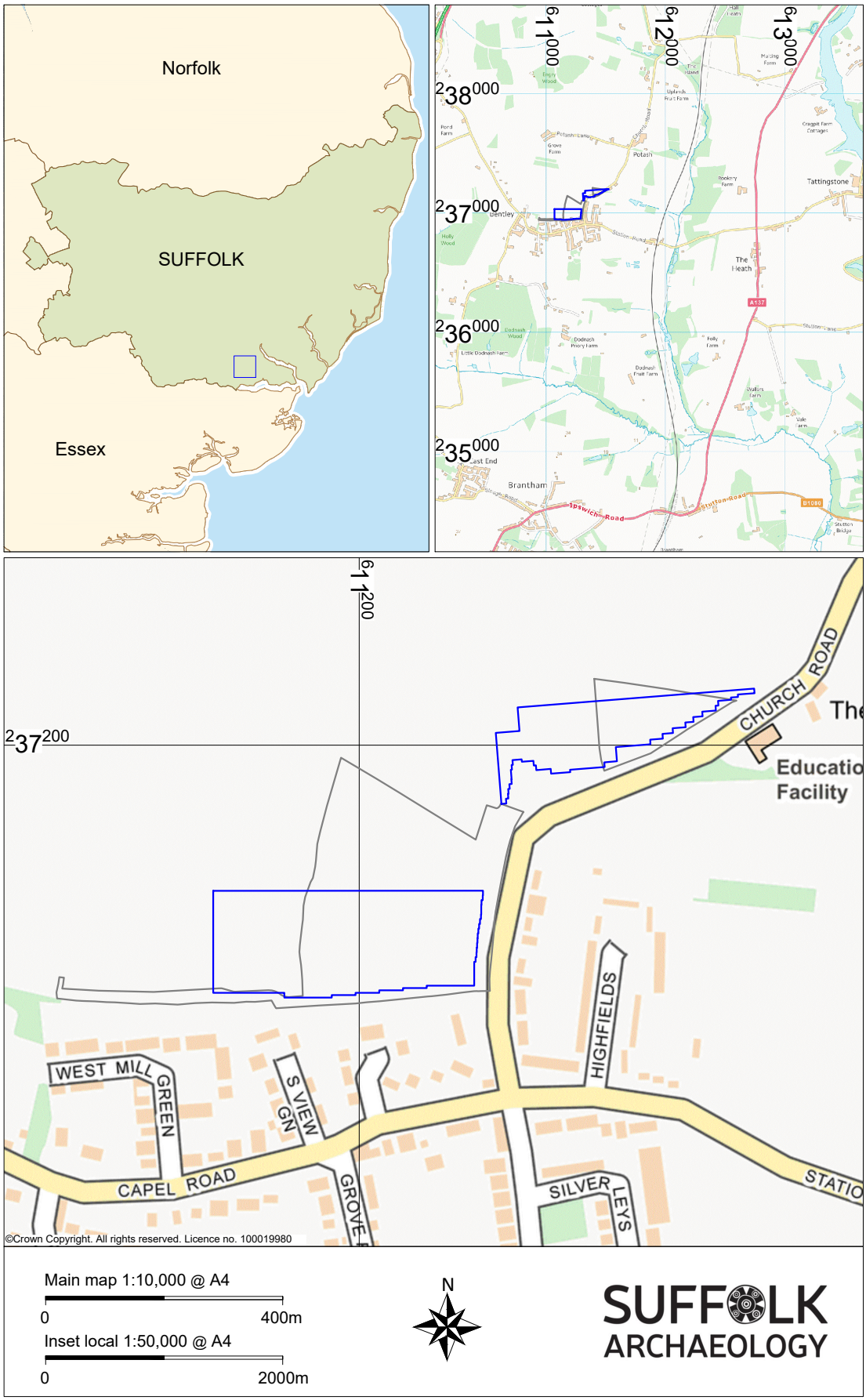

Figure 1. Site location showing assessment area (blue) and site boundary (grey)

2. Geology and topography

Two separate survey areas located in two adjoining fields were surveyed in February 2018 on the northern edge of the settlement of Bentley (TM 1132 3709). The fields lie to the west of Church Road (Fig.1), where the topography slopes from 39m above Ordnance Datum (AOD) in the southwest to 37m AOD in the northeast. Overhead electric powerlines were present in both fields.

The bedrock geology consists of Red Crag Formation sand, formed up to 4 million years ago in the Quaternary and Neogene Periods when the local environment was dominated by shallow seas (BGS 2018). Overlain by superficial deposits of Lowestoft Formation sands and gravels to the west, and Kesgrave Catchment sands and gravels to the east, formed up to 3 million years ago in the Quaternary Period in an environment dominated by rivers (BGS 2018).

3. Archaeology and historical background

A geophysical survey was required by Rachael Abraham of SCCAS/CT to inform the archaeological evaluation brief for the developments proposed within the fields. A series of undated cropmarks (BTY 006) were recorded on air photographs within both fields, that have been interpreted as overlapping ditches, linear features and a former river course. Recorded 450m to the southwest is a polished Neolithic axe head (BTY 007). A Roman coin (BTY 005) was recovered 475m to the southwest. The Norman Church of St Mary (BTY 014) is located 1175m to the northeast, the ancient Engry Wood (BTY 019) is recorded 1085m to the northwest.

An examination of historic mapping held by SACIC was made. The Ordnance Survey (OS) maps from 1882 to 1928 reveal that internal field boundaries that were recorded to the north and west of the western field had been removed before the publication of the 1958 OS map. No changes from the current configuration were recorded within the eastern field.

4. Methodology

Instrument type

A Bartington DualGRAD 601-2 fluxgate gradiometer was employed to undertake the detailed geophysical survey; the weather, ground and geological soil conditions were found to be suitable.

Instrument calibration and settings

One hour was allocated to allow the instruments' sensors to reach optimum operating temperature before the survey commenced each day. The ground was frozen on day one, followed by rain on day two. Instrument sampling intervals were set to 0.25m along 1m traverses (four readings per metre).

Survey grid layout

The detailed survey was undertaken within 20m grids (Fig. 2, blue and green grids), orientated *c*. east to west and geolocated employing a Leica Viva GS14 Smart Rover RTK GLONASS/GPS, allowing an accuracy of +/- 0.03m. Data were converted to National Grid Transformation OSTN15.

Data capture

Detailed fluxgate gradiometer survey data points were recorded on an internal data logger that were downloaded and checked for quality at midday and in the evening, allowing grids to be re-surveyed if necessary. A pro-forma survey sheet was completed to allow data composites to be created. Data were filed in unique project folders and backed-up onto an external storage device and then a remote server in the evening.

Data software, processing and presentation

The site had a low magnetic signature allowing the anomalies to contrast well with the magnetic background. Good quality raw survey data was collected and minimal data processing was required. Datasets were composited and processed using DW Consulting's Terrasurveyor v.3.0.33.6; raw grid files, composites and raster graphic plots will be stored and archived in this format. Minimal processing algorithms were undertaken on the raw (Figs. 3 – 4) and processed datasets (Fig. 5); schedules are presented in Appendix 1.

Data composites were exported as raster images into AutoCAD. An interpretation plan based on the combined results of the raw, processed and xy trace plots (Figs. 3 – 5) has been produced (Fig. 6).

Survey grid restoration

Six virtual survey grid stations were placed on survey grid nodes along the baselines of the survey grid, in order to allow the relocation of the geophysical anomalies (Fig. 2).

5. Results and discussion

The fluxgate gradiometer survey recorded a narrow range of low contrast anomalies (Figs. 3, 4, 5 and 6) within both fields surveyed.

Isolated dipolar responses (grey spots) were recorded throughout both datasets, likely to be caused by individual fragments of magnetic material, lost or manured into the ploughsoil horizon. Ceramic building material (CBM) of a modern origin was witnessed within the ploughsoil by the geophysical survey team, it is probable that some of these magnetic readings are caused by the presence of the CBM.

Two large areas of magnetic disturbance (grey hatching) were recorded in the datasets, one in the eastern field demarcates a dump of CBM witnessed by the survey team, presumably placed to create traction for farm vehicles entering the field. The second area was prospected in the western field, recording magnetic material present within the field boundary.

Four weak broad positive anomalies (green hatching) indicative of geological features were recorded in both survey areas. The anomaly recorded in the eastern field is located where a broad dry valley is clearly extant in the topography that is further recorded on air photographs. A smaller weak broad positive anomaly is further recorded to its west, which is more likely to be caused by a discrete geological variation. Two weak broad positive anomalies (green hatching) were recorded in the western field, most likely to be of a geological derivation, however no obvious topographic landforms were witnessed here by the survey team.

Five positive discrete anomalies (orange hatching) indicative of potential archaeological storage or rubbish pits were recorded in both fields, however a modern or geological derivation cannot be ruled out.

Two parallel positive linear anomalies (red hatching) recorded in the dataset of the western field are likely to delineate a relic field boundary ditch, where the extant crop changes to a stubble field. Two stronger positive linear anomalies were recorded in the eastern field that extend into the dry valley, it is possible that these are drainage gullies of an archaeological or agricultural derivation. A third weaker positive linear trend is recorded running northwest to southeast, before leaving the dataset to the south, it is also thought to be a drainage gully.

6. Conclusion

The detailed fluxgate gradiometer survey has recorded geophysical anomalies predominantly of a geological and agricultural derivation. Anomalies indicative of archaeological pits, agricultural ditches and geological variations were further prospected within the dataset.

It would be prudent to further investigate the full range of magnetic anomalies recorded by the magnetometer within the planning application boundary (Fig. 6), to test the interpretations given within this report. Areas that appear devoid of geophysical anomalies should also be further targeted to investigate whether archaeological features remain undetected below the ploughsoil.

Following the conclusion of the fieldwork, the site boundary has been altered to its current arrangement (grey line, Fig. 1), which means that the geophysical survey area (blue line, Fig.1) does not fully cover the footprint of this new site boundary. A proportional next stage of archaeological investigation would be to undertake trial trenching covering the extent of the new boundary, whilst targeting the geophysical anomalies identified within the planning application boundary (Fig. 6), post-determination of the planning application but prior to commencement of the development. This could be controlled by a planning condition attached to any grant of outline planning permission.

7. Archive deposition

The paper and digital archive will be kept at the SACIC office in Needham Market, before deposition in the Suffolk County Council Stores in Bury St Edmunds.

8. Acknowledgements

The fieldwork was undertaken by Cameron Bate, Filipe Santos and Tim Schofield, the project was directed by Tim Schofield. Project management was undertaken by Rhodri Gardner. The Illustrations were created by Tim Schofield and the report was edited by Rhodri Gardner.

9. Bibliography

Ayala, G., et al, 2004, *Geoarchaeology; Using Earth Sciences to Understand the Archaeological Record.* English Heritage.

Brown, N., and Glazebrook, J, (eds), 2000, *Research and Archaeology: A Framework for the Eastern Counties, 2. Research Agenda and Strategy.* East Anglian Archaeology Occasional Paper No. 8.

Chartered Institute for Archaeologists, 2014, *Standard and Guidance for Archaeological Geophysical Survey.*

Clark, A. J., 1996, *Seeing Beneath the Soil, Prospecting Methods in Archaeology.* BT Batsford Ltd. London.

David, A., *et al*, 2014, *Geophysical Survey in Archaeological Field Evaluation*. Historic England.

Gaffney, C., Gater. J., and Ovenden, S., 2002, *The Use of Geophysical Techniques in Archaeological Evaluations.* IFA Technical Paper No.6.

Gaffney, C., and Gater. J., 2003, *Revealing the Buried Past, Geophysics for Archaeologists.* Tempus Publishing Ltd.

Historic England, 2015, *Management of Research in the Historic Environment (MoRPHE)*.

Gurney, D., 2003, *Standards for Field Archaeology in the East of England.* East Anglian Archaeology Occasional Paper 14.

Medlycott, M. (ed), 2011, *Research and Archaeology Revisited: A revised framework for the East of England.* East Anglian Archaeology Occasional Paper 24.

Schmidt, A., 2001, *Geophysical Data in Archaeology: A Guide to good Practice.* Archaeology Data Service. Oxbow books.

Schmidt, A., et al, 2015, *EAC Guidelines for the use of Geophysics in Archaeology; Questions to ask and Points to Consider*. EAC Guidelines 2.

SCCAS, 2010, *Deposition of Archaeological Archives in Suffolk.*

SCCAS, 2011, *Requirements for a Geophysical Survey*.

Witten, A. J., 2006, *Handbook of Geophysics and Archaeology.* Equinox Publishing Ltd. London.

Websites

British Geological Survey, 2018, http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Survey Station	Easting	Northing
STN 01	611079.901	237062.805
STN 02	611299.902	237062.891
STN 03	611299.932	236982.891
STN 04	611336.480	237217.393
STN 05	611342.838	237137.646
STN 06	611535.848	237233.287

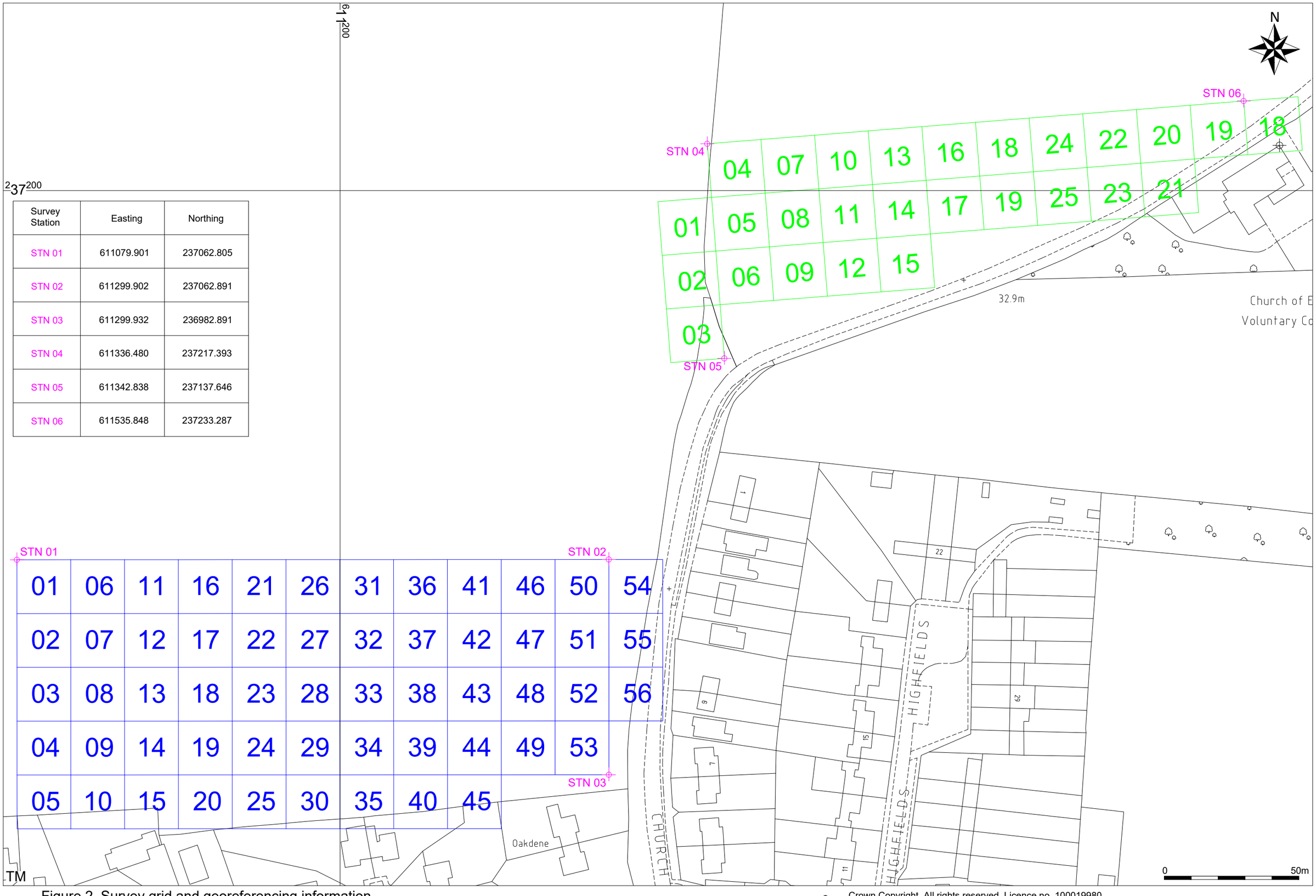

Figure 2. Survey grid and georeferencing information

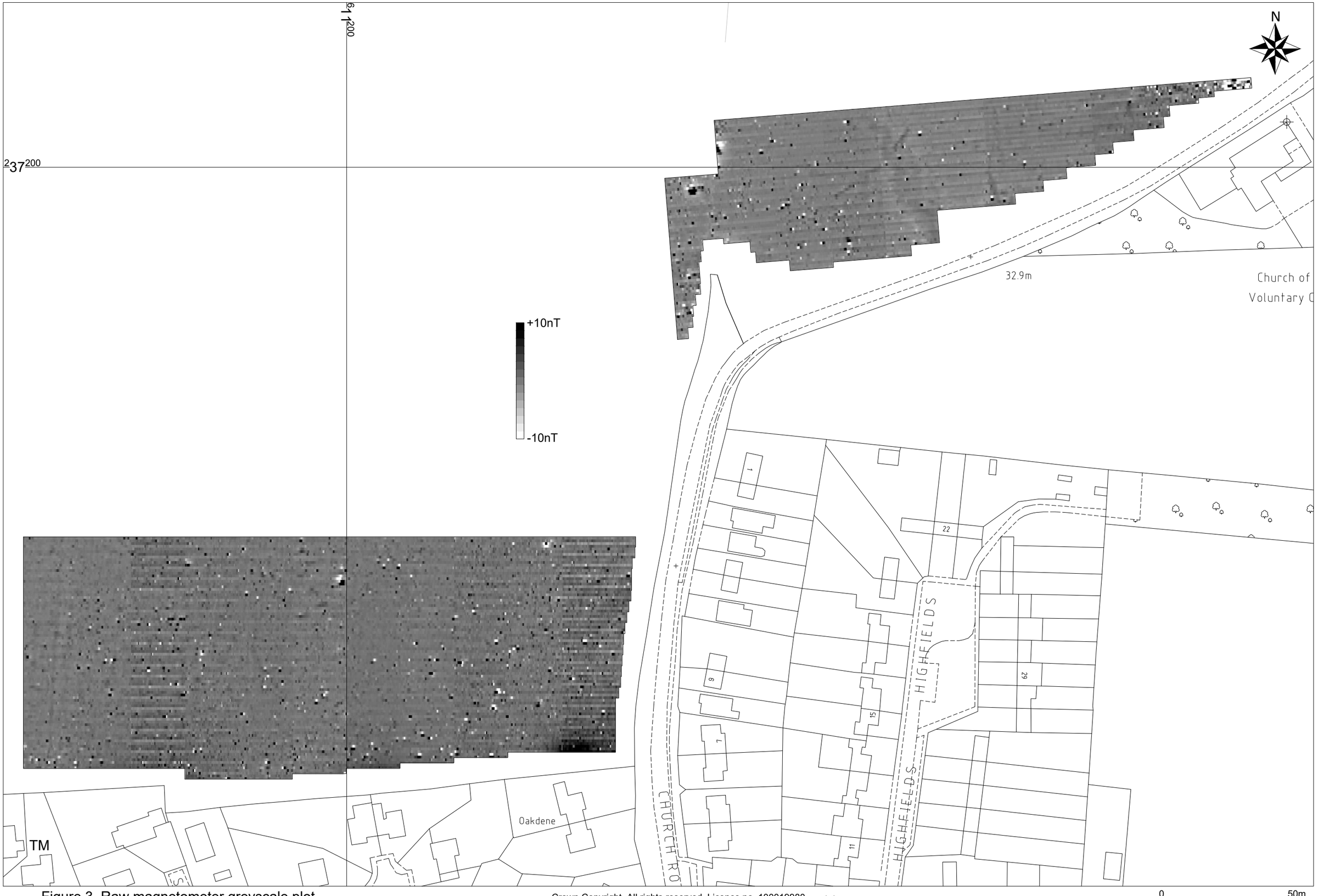

Figure 3. Raw magnetometer greyscale plot

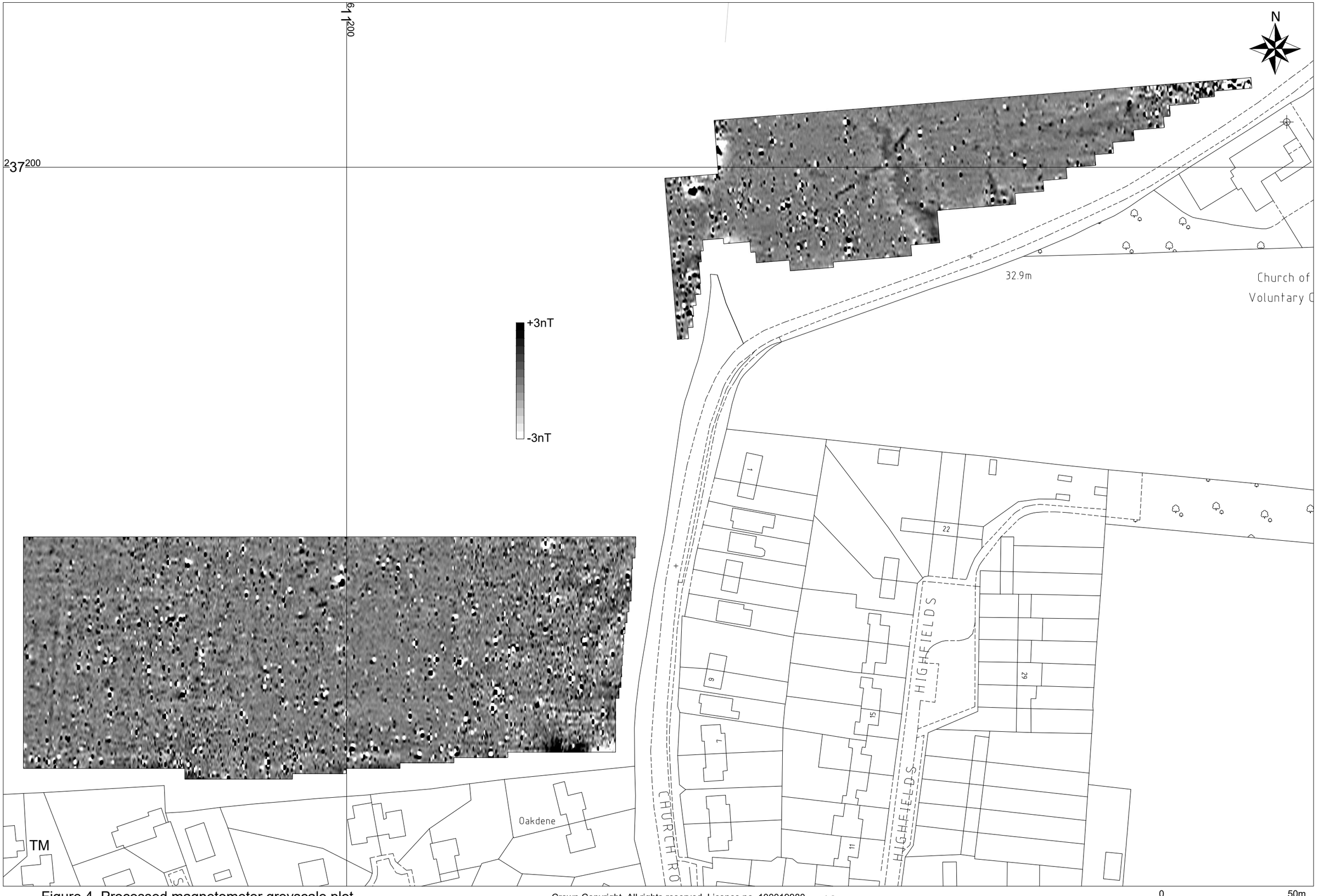

Figure 4. Processed magnetometer greyscale plot

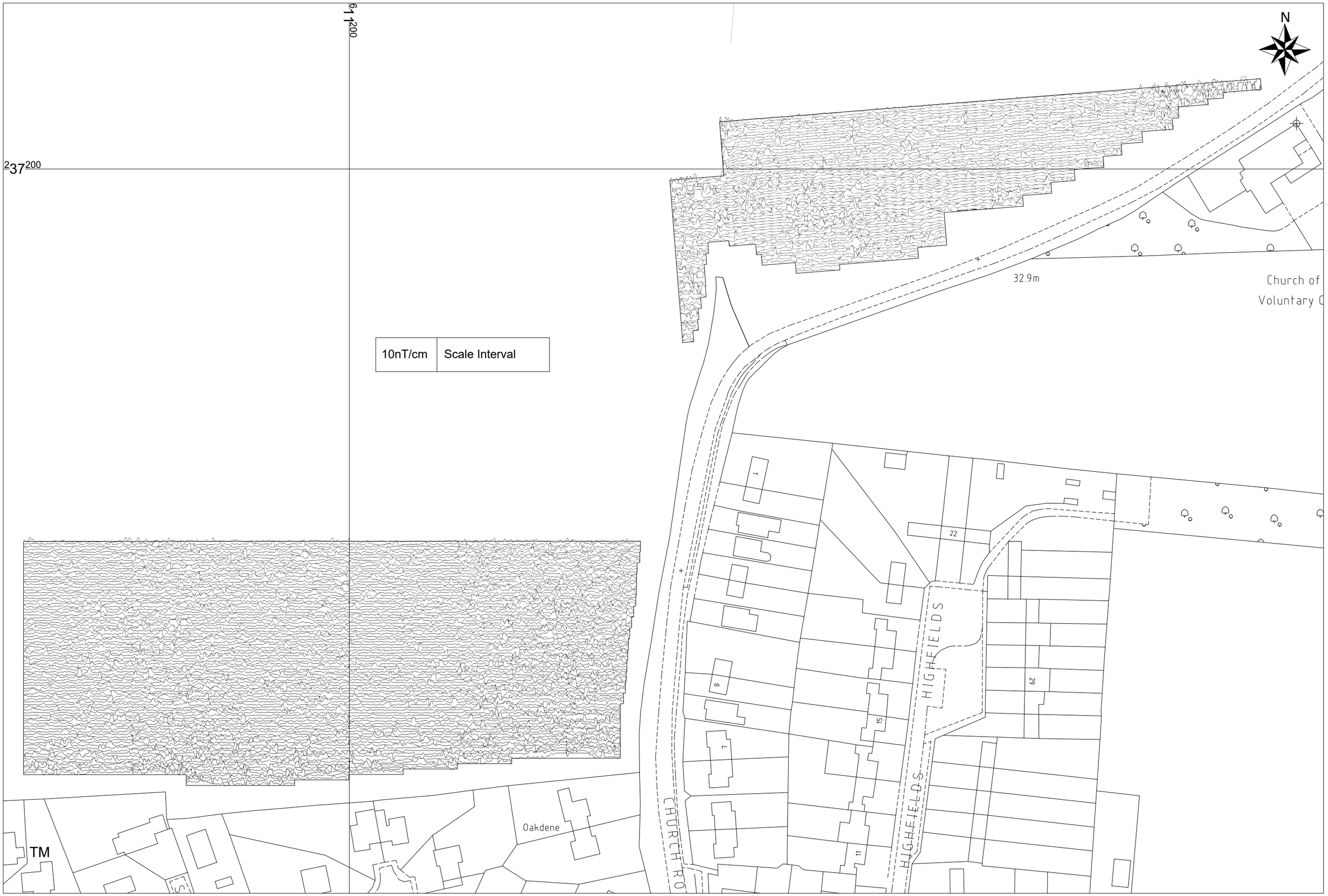

Figure 5. Processed magnetometer xy trace plot

Figure 6. Interpretation plot of magnetometer anomalies

Appendix 1. Metadata sheets

Area 1

Grids

Source Grids: 56
1 Col:0 Row:0 grids\01.xgd
2 Col:0 Row:1 grids\02.xgd
3 Col:0 Row:2 grids\03.xgd
4 Col:0 Row:3 grids\04.xgd
5 Col:0 Row:4 grids\05.xgd
6 Col:1 Row:0 grids\06.xgd
7 Col:1 Row:1 grids\07.xgd
8 Col:1 Row:2 grids\08.xgd
9 Col:1 Row:3 grids\09.xgd
10 Col:1 Row:4 grids\10.xgd
11 Col:2 Row:0 grids\12.xgd
12 Col:2 Row:1 grids\11.xgd
13 Col:2 Row:2 grids\13.xgd
14 Col:2 Row:3 grids\14.xgd
15 Col:2 Row:4 grids\15.xgd
16 Col:3 Row:0 grids\16.xgd
17 Col:3 Row:1 grids\17.xgd
18 Col:3 Row:2 grids\18.xgd
19 Col:3 Row:3 grids\19.xgd
20 Col:3 Row:4 grids\20.xgd
21 Col:4 Row:0 grids\21.xgd
22 Col:4 Row:1 grids\22.xgd
23 Col:4 Row:2 grids\23.xgd
24 Col:4 Row:3 grids\24.xgd
25 Col:4 Row:4 grids\25.xgd
26 Col:5 Row:0 grids\26.xgd
27 Col:5 Row:1 grids\27.xgd
28 Col:5 Row:2 grids\28.xgd
29 Col:5 Row:3 grids\29.xgd
30 Col:5 Row:4 grids\30.xgd
31 Col:6 Row:0 grids\31.xgd
32 Col:6 Row:1 grids\32.xgd
33 Col:6 Row:2 grids\33.xgd
34 Col:6 Row:3 grids\34.xgd
35 Col:6 Row:4 grids\35.xgd
36 Col:7 Row:0 grids\36.xgd
37 Col:7 Row:1 grids\37.xgd
38 Col:7 Row:2 grids\38.xgd
39 Col:7 Row:3 grids\39.xgd
40 Col:7 Row:4 grids\40.xgd
41 Col:8 Row:0 grids\41.xgd
42 Col:8 Row:1 grids\42.xgd
43 Col:8 Row:2 grids\43.xgd

44 Col:8 Row:3 grids\44.xgd
45 Col:8 Row:4 grids\45.xgd
46 Col:9 Row:0 grids\46.xgd
47 Col:9 Row:1 grids\47.xgd
48 Col:9 Row:2 grids\48.xgd
49 Col:9 Row:3 grids\49.xgd
50 Col:10 Row:0 grids\50.xgd
51 Col:10 Row:1 grids\51.xgd
52 Col:10 Row:2 grids\52.xgd
53 Col:10 Row:3 grids\53.xgd
54 Col:11 Row:0 grids\54.xgd
55 Col:11 Row:1 grids\55.xgd
56 Col:11 Row:2 grids\56.xgd

Raw Data

Filename	Bentley 1 Raw -10 +10.xcp
Description	
Instrument Type	Grad 601 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	960 x 100
Survey Size (meters)	240 m x 100 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	100.00
Min	-100.00
Std Dev	2.80
Mean	1.13
Median	0.95
Composite Area	2.4 ha
Surveyed Area	1.9021 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Raw Data Schedule

Processes:
1 Display Clip: -10 +10

Processed Data

Filename	Bentley 1 Pro Mag -3 +3.xcp
Description	
Instrument Type	Grad 601 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	960 x 100
Survey Size (meters)	240 m x 100 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	99.21
Min	-101.03
Std Dev	2.66
Mean	0.11
Median	0.00
Composite Area	2.4 ha
Surveyed Area	1.9021 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Processed Data Schedule

Processes:
1 Destripe Median Sensors: All
2 Display Clip: -3 +3
3 Graduated Shade

Area 2

Grids

Source Grids: 25
1 Col:0 Row:1 grids\01.xgd
2 Col:0 Row:2 grids\02.xgd
3 Col:0 Row:3 grids\03.xgd
4 Col:1 Row:0 grids\04.xgd
5 Col:1 Row:1 grids\05.xgd
6 Col:1 Row:2 grids\06.xgd
7 Col:2 Row:0 grids\07.xgd
8 Col:2 Row:1 grids\08.xgd
9 Col:2 Row:2 grids\09.xgd
10 Col:3 Row:0 grids\10.xgd
11 Col:3 Row:1 grids\11.xgd
12 Col:3 Row:2 grids\12.xgd
13 Col:4 Row:0 grids\13.xgd
14 Col:4 Row:1 grids\14.xgd
15 Col:4 Row:2 grids\15.xgd
16 Col:5 Row:0 grids\16.xgd
17 Col:5 Row:1 grids\17.xgd
18 Col:6 Row:0 grids\24.xgd
19 Col:6 Row:1 grids\25.xgd
20 Col:7 Row:0 grids\22.xgd
21 Col:7 Row:1 grids\23.xgd
22 Col:8 Row:0 grids\20.xgd
23 Col:8 Row:1 grids\21.xgd
24 Col:9 Row:0 grids\19.xgd
25 Col:10 Row:0 grids\18.xgd

Raw Data

Filename	Bentley 2 Mag Raw -10 +10.xcp
Description	
Instrument Type	Grad 601 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	880 x 80
Survey Size (meters)	220 m x 80 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	100.00
Min	-73.32
Std Dev	3.04
Mean	0.00
Median	-0.05
Composite Area	1.76 ha
Surveyed Area	0.8009 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Raw Data Schedule

Processes: 1
1 Display Clip -10 +10

Processed Data

Filename	Bentley 2 Mag Pro -3 + 3.xcp
Description	
Instrument Type	Grad 601 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	880 x 80
Survey Size (meters)	220 m x 80 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	100.77
Min	-72.55
Std Dev	2.96
Mean	0.05
Median	0.00
Composite Area	1.76 ha
Surveyed Area	0.8009 ha
Program	
Name	TerraSurveyor
Version	3.0.33.6

Processed Data Schedule

Processes:
1 Destripe Median Sensors: All
2 Display Clip: -3 +3
3 Graduated Shade

Appendix 2. Technical data

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain; sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark, 1996). For instance, the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater, 2003). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the material's magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combines with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark, 1996). These anomalies are subtler in nature, being derived from material that has been magnetically enhanced by cultural activity which has become concentrated into features over time. Anomalies that have temporary

magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field boundaries (David *et al*, 2014).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached to a cart. Each sensor contains two fluxgate magnetometers with a 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin and a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances, the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature. In Britain high positive readings are recorded to the south of the anomaly with high negative readings recorded to the north.

Appendix 3. OASIS form

OASIS ID: suffolka1-308207

Project details

Project name	Land West of Church Road, Bentley, Suffolk, Magnetometer Survey
Short description of the project	In February 2018 Suffolk Archaeology Community Interest Company (SACIC) undertook a detailed fluxgate gradiometer survey on land west of Church Road, Bentley, Suffolk. Two fields (a total of 2.7ha) were prospected for anomalies of an archaeological derivation, positioned over the proposed developments footprints. The western field was given over to cropped stubble and the eastern field was set-aside to scrubland. The detailed fluxgate gradiometer survey prospected geophysical anomalies that are likely to be of a geological and agricultural derivation, along with those indicative of archaeological pits, agricultural ditches and geological variations.
Project dates	Start: 08-02-2018 End: 09-02-2018
Previous/future work	No / Yes
Any associated project reference codes	BTY 044 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 - Operations to a depth more than 0.25m
Monument type	ANOMALIES INDICATIVE OF GEOLOGICAL DRY VALLEY Uncertain
Monument type	ANOMALIES INDICATIVE OF RUBBISH PITS Uncertain
Monument type	ANOMALIES INDICATIVE OF AGRICULTURE Uncertain
Significant Finds	NONE None
Methods & techniques	"'Geophysical Survey"'
Development type	Housing estate
Development type	Public building (e.g. school, church, hospital, medical centre, law courts etc.)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Red Crag Formation Sand
Drift geology (other)	Lowestoft Formation Sands and Gravels, Kesgrave Catchment Sands and Gravels
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK BABERGH BENTLEY Land West of Church Road, Bentley, Suffolk
Study area	2.7 Hectares
Site coordinates	TM 1132 3709 51.991453746383 1.078275007263 51 59 29 N 001 04 41 E Point
Height OD / Depth	Min: 37m Max: 39m

Project creators

Name of Organisation	Suffolk Archaeology CIC
Project brief originator	Local Planning Authority (with/without advice from County/District Archaeologist)

Project design originator	Rachael Abraham
Project director/manager	Tim Schofield
Project supervisor	Tim Schofield
Type of sponsor/funding body	developer
Name of sponsor/funding body	D. E. J. Baker

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Contents	"Survey"
Digital Media available	"Geophysics","Survey","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"Survey"
Paper Media available	"Report","Survey ","Unpublished Text"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Land West of Church Road Bentley, Suffolk, BTY 044, Geophysical Survey Report 2018/019
Author(s)/Editor(s)	Schofield, T. P.
Other bibliographic details	2018/019
Date	2018
Issuer or publisher	Suffolk Archaeology CIC
Place of issue or publication	Needham Market
Description	A4 Report with A3 fold-out figures
URL	www.suffolkarchaeology.co.uk

Entered by	Timothy Schofield (tim.schofield@suffolkarchaeology.co.uk)
Entered on	4 January 2019

Appendix 4. Written scheme of investigation

SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Land West of Church Road

Bentley, Suffolk

Client:
D. E. J. Baker & Son, c/o Miss HV Adcock (CODE Development Planners)

Date:
February 2018

BTY 044
Written Scheme of Investigation and Risk Assessment – Geophysical Survey
Author: Tim Schofield HND BSc MCIfA

Contents

List of Figures

Appendices

Project details

Planning Application No:	TBC
Curatorial Officer:	TBC (SCCAS/CT)
Grid Reference:	TM 1132 3709
Area:	*c*. 3.16ha
HER Event No/Site Code:	BTY 044
OASIS Reference:	308207
Project Start date:	8th & 9th February 2018
Project Fieldwork Duration:	*c*. 2 days
Client/Funding Body:	D. E. J. Baker, c/o Miss HV Adcock (CODE Development Planners)
SACIC Project Manager:	Tim Schofield
SACIC Project Officer:	Tim Schofield
SACIC Job Code:	TBC

1. Introduction

- A program of geophysical survey is required at two separate sites to the west of Church Road, Bentley, Suffolk (Fig. 1), prior to determination of the planning application, in accordance with paragraph 128, 129 and 141 of the National Planning Policy Framework.
- The work is required by the archaeological advisers (to be confirmed) to the Local Planning Authority (LPA), of Suffolk County Council Archaeological Service/Conservation Team (SCCAS/CT).
- The larger of the two sites (2.19ha) located farthest west, is outlined for a proposed housing development, the smaller area (0.97 ha) to the northwest of Bentley Primary School has been outlined for a proposed school drop-off point (Fig. 2).
- Suffolk Archaeology have been contracted to carry out a *c.* 3.16ha survey of the two areas that will be subject to ground disturbance from the proposed developments. This Written Scheme of Investigation (WSI) details how the survey will meet the requirements as laid out in the SCCAS/CT geophysical survey guidelines (SCCAS/CT 2017), and has been submitted to SCCAS/CT 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/CT.
- It should be noted that the geophysical survey is only a first stage in a potential program of works. This WSI covers the geophysical survey only. Any further stages of archaeological work that are required in relation to the proposed development after the survey will be specified by SCCAS/CT, and will require new documentation (Brief and WSI) and estimate of costs. Such works could have considerable time and cost implications for the development and the client is advised to consult with SCCAS/CT as to their obligations following receipt of the geophysical survey report.

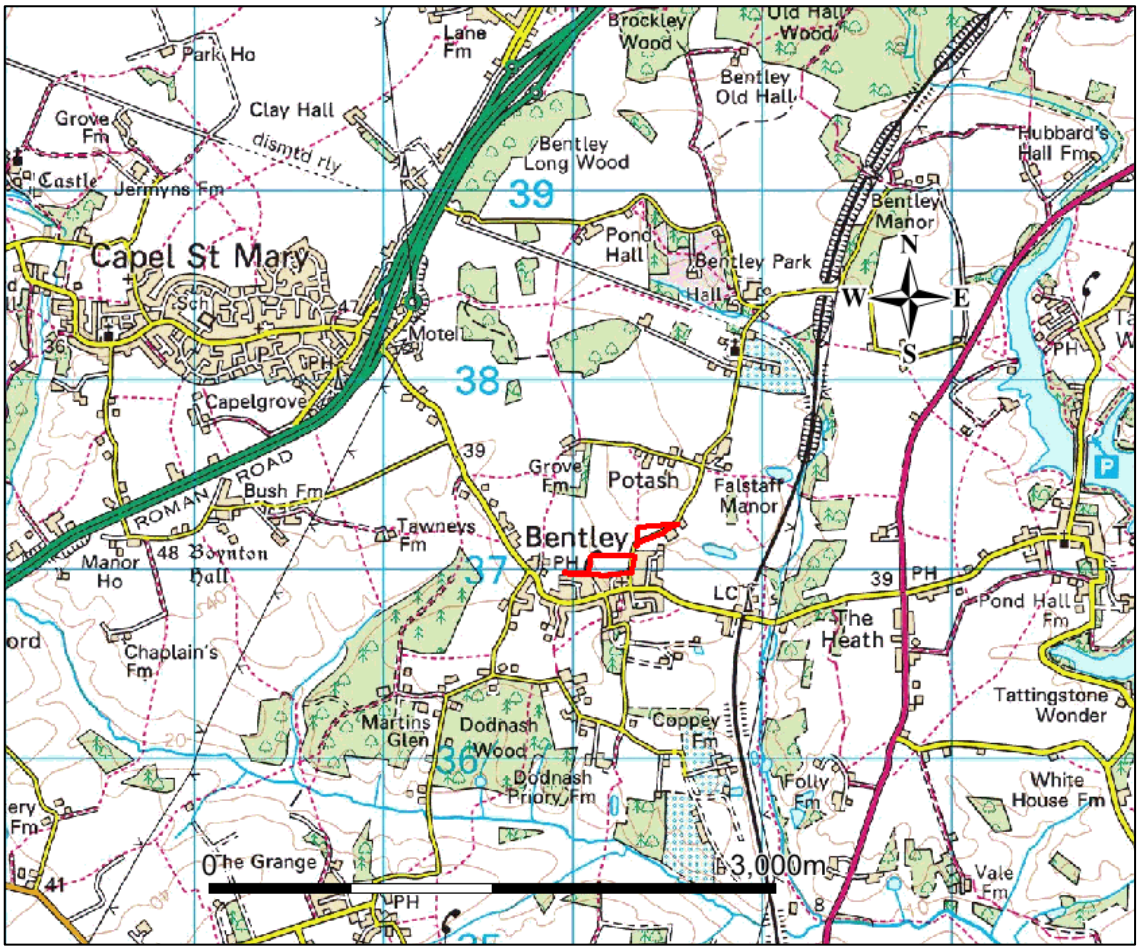

Figure 1. Site locations map

2. The Site

- The sites lie within an arable landscape, located on the northern edge of the settlement of Bentley. Two separate areas are to be surveyed that are centred on TM 1132 3709 to the west of Church Road (Fig.1). Overhead electric powerlines run to the north of the western site and are further present crossing the western edge of the eastern site. Caution shall be maintained when working near the overhead power cables.
- Topographically the areas slope gently from 39m above Ordnance Datum (AOD) in the southwest to 37m AOD in the northeast.
- The bedrock geology consists of Red Crag Formation sand, formed up to 4 million years ago in the Quaternary and Neogene Periods when the local environment was dominated by shallow seas (BGS 2018). This is overlain by superficial deposits of

Lowestoft Formation sands and gravels to the west, and Kesgrave Catchment sands and gravels to the east, formed up to 3 million years ago in the Quaternary Period in an environment dominated by rivers (BGS 2018).

3. Archaeological and Historical Background

- The geophysical survey is required by SCCAS/CT in order to inform the archaeological evaluation brief for the proposed developments.
- The sites are located in two separate agricultural fields. A series of cropmarks (BTY 006) have been recorded on air photographs over the location of both survey areas of unknown date, they have been interpreted as overlapping ditches and linear features and also a former river course. Recorded 450m to the southwest is a polished Neolithic axe head (BTY 007). A Roman coin (BTY 005) is recorded 475m to the southwest. The Norman Church of St Mary (BTY 014) is located 1175m to the northeast. The ancient woodland known as Engry Wood (BTY 019) is located 1085m to the northwest.
- A full search of the Suffolk Historic Environment Record has been commissioned and will be used within the survey report.
- An initial examination of historic mapping held by SACIC has been made. The Ordnance Survey (OS) maps from 1882 to 1928 reveal that a series of boundaries recorded to the north and west of the western site have been removed, presumably to enlarge the field some time before the publication of the 1958 OS map. The eastern site has broadly stayed the same since the 1882 OS publication.

4. Project Objectives

- A systematic fluxgate gradiometer survey is to be undertaken across all areas of the proposed reservoir site where groundworks will be carried out.

Figure 2. Site boundaries (red), proposed geophysical survey grids (blue)

0 100m

5. Geophysical Survey Method Statement

5.1. Management

- The project will be managed by SACIC Project Officer Tim Schofield in accordance with the principles of *Management of Research Projects in the Historic Environment* (MoRPHE, Historic England 2015).
- SCCAS/CT will be given five days' notice of the commencement of the fieldwork and arrangements made for a SCCAS/CT site visit if required.
- Full details of project staff are given in section 6 below.

5.2. Project preparation

- An event number and site code have been obtained from the SCCAS/CT HER Officer and will be included on all future project documentation. An HER search has been requested.
- An OASIS online record has been initiated and key fields in details, location and creator forms have been completed.
- A 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 geophysical survey', December 2014.
- The fieldwork will be carried out by members of SACIC led by Project Officer Tim Schofield. The fieldwork team will be drawn from a pool of suitable staff at SACIC.
- The project requires the survey of *c*. 3.16 hectares over two separate sites (Fig. 2). The survey areas are based on site limits provided by the client, minor modifications to the survey area may need to be made onsite to respect any areas of disturbance/contamination or other obstacles.

- The outline of the survey area ensures that a 5-10m exclusion zone can be maintained from surrounding field boundaries, in order to minimise the amount of associated magnetic disturbance.

Instrument type and set-up

- The site will be surveyed using a Bartington Dual-Grad 601-2 which has high sensor sensitivity combined with rapid ground coverage. Good contrast between the magnetic susceptibility of a feature's fill (charcoal rich or humic deposits providing the best soil medium) and the local magnetic background signature of the superficial deposits will be important in achieving successful survey results.
- Best practice dictates that sensors will be secured on the same side of the instrument until the completion of the survey, and sensor heights equalised to achieve a consistent elevation across the area. The instrument will be switched on and left for at least 20 minutes before the survey of the first grid to allow the sensors to reach a suitable operating temperature.
- A zero station with low magnetic susceptibility shall be prospected within the field to allow the correction of diurnal sensor drift. This unique station will be employed throughout the survey providing a common calibration location.

Sampling interval and grid size

- The 20m survey grid will be set-out using a Leica Viva Glonass Smart Rover GS14 to the Ordnance Survey OSGB36, converted to the National Grid Transformation OSTN15 datum that has an accuracy of +/- 0.03m. Regular testing of the instruments accuracy will be undertaken employing stations with known ETRS89 coordinates. All raw data recorded by the GPS will be uploaded to the project folder, suitably labelled and kept as part of the project archive.
- A 1m traverse interval and 0.25m sample interval will be utilised.

Data capture and archiving

- A pro-forma survey sheet will be completed each day; unique grid numbers will be

allocated to enable a data composite to be created. Instrument readings will be recorded on the internal data logger and downloaded to a laptop at midday and also in the evening, this will allow the data to be checked for quality on site and for grids to be re-surveyed if required.

- Data will be filed in project specific folders separated into daily datasets. The daily datasets will be combined into a single composite on completion of the fieldwork.
- Data will be stored in project specific folders that will be downloaded onto a laptop and then backed-up onto an external server in the evening of each day.
- Metadata sheets will be completed and inserted into the report as an appendix.
- All on-site derived site data will be entered onto a digital (Microsoft Access) SACIC database compatible with the Suffolk HER.

Data processing and presentation

- Raw survey data will be collected to a high standard to enable only minimal processing of the datasets to be required. Typically, these algorithms may comprise zero median sensor. The data will also be clipped at a suitable level to enable the anomalies to be presented with best clarity.
- Raw and processed greyscale plots and xy trace plots of the datasets shall be exported from Terrasurveyor into AutoCAD.
- An interpretation plan based on the combined interpretations of the raw, processed and xy trace plots will be produced using AutoCAD. All figures shall be georeferenced within the National Grid and printed at an appropriate scale.

Software

- The software used to process the data will be DW Consulting's Terrasurveyor v3.0.33.6. Images will be exported from Terrasurveyor into a geo-referenced grid within an AutoCAD drawing. Interpretation plans of the anomalies will then be digitised using AutoCAD.

5.4. Report

- The report will be commensurate with the results of the fieldwork and will be consistent with the principles of Management of Research Projects in the Historic Environment (MoRPHE, Historic England, 2015), Geophysical survey in Field Evaluation (Historic England, 2008) and the Standard and Guidance for Archaeological Geophysical Survey (Chartered Institute for Archaeologists, 2014), containing the following: a summary, description of the project background, site location, survey methodology, detailed description of the nature, location and extent of anomalies, discussion of the anomalies, impact assessment, site potential and possible further work. Scaled raw, processed, xy data plans and an interpretation plan will also be included.
- 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.
- Metadata sheet tables will form one of the appendices within the report.
- A technical data sheet will be included as an appendix.
- 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/CT for approval within 6 months of completion of fieldwork.

5.5. Project archive

- On approval of the report a printed and bound copy will be lodged with the Suffolk HER. A digital .pdf file will also be supplied, together with a digital and fully georeferenced vector plan showing the application area and survey location, compatible with MapInfo software.
- The online OASIS form for the project will be completed and a .pdf version of the report uploaded to the OASIS website for online publication by the Archaeological Data Service. A paper copy of the form will be included in the project archive.

- A second bound copy of the report will be included with the project archive.
- A digital .pdf copy of the approved report will be supplied to the client, together with our final invoice for outstanding fees. Printed and bound copies will be supplied to the client on request.
- The project archive, consisting of all paper and digital records, will be deposited in the SCCAS/CT 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/CT (SCCAS/CT 2017).
- The project costing includes a sum to meet SCCAS/CT archive charges. A form transferring ownership of the archive to SCCAS/CT 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/CT, they will be expected to either nominate another suitable depository approved by SCCAS/CT.

5.6. Bibliography

Ayala, G., et al., 2004, *Geoarchaeology; Using Earth Sciences to Understand the Archaeological Record.* English Heritage.

Brown, N., and Glazebrook, J, (eds), 2000, *Research and Archaeology: A Framework for the Eastern Counties, 2. Research Agenda and Strategy.* East Anglian Archaeology Occasional Paper No. 8.

Chartered Institute for Archaeologists, 2014, *Standard and Guidance for Archaeological Geophysical Survey.*

Clark, A. J., 1996, *Seeing Beneath the Soil, Prospecting Methods in Archaeology.* BT Batsford Ltd. London.

David, A., *et al.*, 2014, *Geophysical Survey in Archaeological Field Evaluation*. Historic England.

Gaffney, C., Gater. J., and Ovenden, S., 2002, *The Use of Geophysical Techniques in Archaeological Evaluations.* IFA Technical Paper No.6.

Gaffney, C., and Gater. J., 2003, *Revealing the Buried Past, Geophysics for Archaeologists.* Tempus Publishing Ltd.

Historic England, 2015, *Management of Research in the Historic Environment (MoRPHE)*.

Gurney, D., 2003, *Standards for Field Archaeology in the East of England.* East Anglian Archaeology Occasional Paper No 14.

Medlycott, M. (Ed)., 2011, *Research and Archaeology Revisited: A revised framework for the East of England.* EAA Occasional Paper 24.

Schmidt, A., 2001, *Geophysical Data in Archaeology: A Guide to good Practice.* Archaeology Data Service. Oxbow books.

Schmidt, A., et al., 2015, *EAC Guidelines for the use of Geophysics in Archaeology; Questions to ask and Points to Consider*. EAC Guidelines 2.

SCCAS, 2017, *Deposition of Archaeological Archives in Suffolk.*

SCCAS, 2017, *Requirements for a Geophysical Survey*.

Witten, A. J., 2006, *Handbook of Geophysics and Archaeology.* Equinox Publishing Ltd. London.

Websites

British Geological Survey 2018

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

6. Project Staffing

6.1. Management

SACIC Manager	Dr Rhodri Gardner
SACIC Project Manager	John Craven

6.2. Fieldwork

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

Name	Job Title	First Aid	Other skills/qualifications
Tim Schofield	Project Officer	Yes	Geophysical Surveyor
Catherine Douglas	Project Officer	Yes	Geophysical Surveyor
Cameron Bate	Project Assistant	No	Geophysical Surveyor

6.3. Report production

The production of the site report, graphics and submission of the project archive will be carried out by Tim Schofield.

Appendix 1. Health and Safety

1. Introduction

The project will be carried out following the SACIC Health and Safety Management System at all times. The SACIC Health and Safety Policy Statement reads as follows:

Suffolk Archaeology Community Interest Company is committed to ensuring the health, safety and welfare of its employees, and it will, so far as is reasonably practicable, establish procedures and systems necessary to implement this commitment and to comply with its statutory obligations on health and safety. Our Personnel are informed of their responsibilities to ensure they take all reasonable precautions, to ensure the safety, health and welfare of those that are likely to be affected by the acts and emissions of our organisations undertakings.

Suffolk Archaeology Community Interest Company understands our duty to identify the significant hazards that may be created by our undertakings and to risk assess these accordingly to ensure that suitable and effective controls are implemented to minimise risk to a suitable level as far as is reasonably practicable.

We also acknowledge our duty, so far as is reasonably practicable:

- *To provide a safe working environment for our workforce, fulfil our statutory commitments and actively manage and supervise health and safety at work;*
- *To identify the risks associated with our business activities and ensure suitable and sufficient control measures are in place.*
- *Ensure regular consultation with our employees on matters which affect their health and Safety.*
- *To ensure that all plant and equipment used by our employees is fit for purpose and adequately maintained.*
- *To provide suitable storage and ensure safe handling of Hazardous substances.*
- *To ensure that all workers are competent to undertake their daily work activities by providing all relevant information and training, consideration will also be given to any employees who do not have English as a first language.*
- *To prevent accidents and cases of work related ill health by ensuring a robust reporting and investigation system is in place.*
- *To liaise and communicate effectively regarding health and safety matters when working on other persons premises.*
- *To ensure that there is an effective system of induction, training, communication and supervision to other persons visiting or working on our premises.*
- *To have access to competent advice, this will be provided by Agility UK (Training and Consultancy) Ltd. Who will assists us in the continuous improvement in our health and safety performance and management through regular review and revision of this policy; and to provide suitable resources required to make this policy and our Health and Safety arrangements effective.*

2. Specific project issues

Introduction

All SACIC staff will be aware that they have a responsibility to:

- Take care of their own health and safety and that of others who may be affected by what they do, or fail to do, at work.
- Follow safe systems of work and other precautions identified in the project risk assessments.
- Report any changes to personal circumstances that may affect their ability to work safely.
- Report potential hazards, incidents and near misses to the Project Officer/supervisor.

A pre-site inspection has been made of the site and applicable SACIC Risk Assessments for the project are included below.

All SACIC staff are experienced in working on a variety of archaeological sites and permanent staff all hold a CSCS (Construction Skills Certification Scheme) card. All staff have been shown the SACIC Health and Safety Manual, copies of which are held at the SACIC office in Needham Market. All staff will read the site WSI and Risk Assessments and receive a site safety induction from the Project Officer prior to starting work. All staff will be issued with appropriate PPE.

From time to time it may be necessary for site visits by other SACIC staff, external specialists, SCCAS/CT staff or other members of the public. All such staff and visitors will be issued with the appropriate PPE and will undergo the required inductions.

Site staff, official visitors and volunteers are all covered by SACIC insurance policies. SACIC also has professional negligence insurance. Copies of these policies are available on request.

Welfare facilities

Due to the limited nature of the project, it is proposed that SACIC staff will work from their vehicle and travel to public facilities if required. A vehicle will be on site at all times.

First Aid

A member of staff with the First Aiders at Work qualification will be on site at all times. A First Aid kit and a fully charged mobile will also be in vehicle/on site at all times.

Site access and security

Access to the sites is off Church Road to the east, the entrance is located on the corner of the field between the two sites. Both areas are private arable land, bounded by hedgerows but open to general access.

Contaminated ground

Details of any ground contamination have not been provided by the client. If any such is identified then groundworks will cease until adequate safety and environmental precautions are in place. Advice will be sought from HSE and relevant authorities if required concerning any of these issues.

Hazardous Substances

No hazardous substances are specifically required in order to undertake the archaeological works.

Underground services

Details of known services have not been provided by the client.

Overhead Powerlines

Overhead powerlines cross the northern boundary of the western area, and bisect the western side of the eastern area.

Personal Protective Equipment (PPE)

The following PPE is issued to all site staff as a matter of course. Additional PPE will be provided if deemed necessary.

- Hard Hat (to EN397).
- High Visibility Clothing (EN471 Class 2 or greater).
- Safety Footwear (EN345/EN ISO 20346 or greater – to include additional penetration-resistant midsole).
- Gloves (to EN388).

- Eye Protection (safety glasses to at least EN 166 1F).

SACIC Environment Policy

Suffolk Archaeology is committed to the sustainable management of the local and global environment to support local communities and growth in our local economy. We will strive to reduce our carbon emissions, to protect and enhance the natural and historic environment and to tackle the issues of a changing climate. In delivering our services, we are committed to meeting all relevant regulatory, legislative and other requirements, and to the continual improvement of our environmental performance.

We will endeavour to:

- Prevent environmental pollution and minimise waste;
- Reduce our carbon emissions;
- Continually improve our energy efficiency and reduce our use of resources;
- Reduce the impact of vehicle travel by our employees;
- Implement sustainable procurement practices where possible;
- Enhance biodiversity, conserve distinctive landscapes and protect the historic environment.

All existing and new SACIC subcontractors are issued annually with an Environmental Guidance Note For Contractors.

On site the SACIC Project Officer will monitor environmental issues and will alert staff to possible environmental concerns. In the event of spillage or contamination, e.g. from plant or fuel stores, EMS reporting and procedures will be carried out in consultation with the SACIC EMS Officer.

The client and/or landowner has not informed SACIC of any environmental constraints upon the development area but none are expected as the site is wholly within arable agricultural use

All rubbish will be bagged and removed either to areas designated by the client or returned to SACIC for disposal.

3. Project Contacts

SACIC

SACIC Manager	Dr Rhodri Gardner	01449 900120
SACIC Project Manager	John Craven	01449 900121
SACIC Finds Dept	Richenda Goffin	01449 900129
SACIC H&S	John Craven	01449 900121
SACIC EMS	Jezz Meredith	01449 900124
SACIC Outreach Officer	Alex Fisher	01449 900125

Emergency services

Local Police		101
Local GP	Capel St Mary Surgery, 36 The Street, IP9 2EE	01473 310203
Location of nearest A&E	Ipswich Hospital, Heath Road, IP4 5PD	01473 702033
Environment Agency	Customer Services Line (8am to 6pm)	03708 506 506
	24 hour Emergency Hotline	0800 807060
Essex and Suffolk Water	24 hour Emergency Hotline	0845 782 0999
National Gas Emergency Service	Gas emergency hotline	0800 111 999
UK Power Networks	East England electricity emergency hotline	0800 783 8838
Anglian Water	24 hour Emergency Hotline	08457 145 145

Client contacts

Client	DE Baker & Son, c/o Miss HV Adcock (CODE Development Planners)	
Client Agent		
Site landowner		

Archaeological contacts

Curator	TBC (SCCAS/CT)	01284 741232
Consultant		
EH Regional Science Advisor	Dr Zoe Outram	01223 582707

4. Geophysical Technical Information

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain, sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark). For instance the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth's magnetic field (Gaffney and Gater). Over time the direction of the Earth's magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the materials magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combine with the Earth's magnetic field causing an anomaly to stand out from the background noise (Clark). These anomalies are more subtle in nature, being derived from material that has been magnetically enhanced by cultural activity and become concentrated into features over time. Anomalies that have temporary magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field

boundaries (David, 2011).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached to a pulled cart. Each sensor contains two fluxgate magnetometers with 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin, a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature, in Britain high positive readings are recorded to the south of the feature, and high negative readings are recorded to the north.

SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Geophysical Survey Risk Assessments

A pre-site inspection and assessment has been made of the site and the following SACIC Risk Assessments apply to the project and are included below.

SACIC GSRA1	Manual handling and outdoor working
SACIC GSRA2	Use of hand tools and instrumentation

Geophysical Survey Risk Assessment 1 Manual handling and outdoor working

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Manual handling of survey instruments and working outdoors.	Various.	Extremes of heat, cold and wet weather. Trip hazards.	Hypothermia, heat stroke, sunburn. Minor injuries. Carrying heavy equipment for prolonged periods.	All field staff.	9	All staff provided with appropriate clothing for weather conditions. No staff to work alone in extreme conditions. Regular sweep for trip hazards.	2	T Schofield	05/02/18	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Initial Risk
Residual Risk

Likelihood	Severity	Risk (likelihood x severity)
1. Highly unlikely	1. Slight inconvenience	1-5 Low
2. May occur but very rarely	2. Minor injury requiring first aid	
3. Does occur but only rarely	3. Medical attention required	6-12 Medium
4. Occurs from time to time	4. Major injury leading to hospitalisation	
5. Likely to occur often	5. Fatality or serious injury leading to disablement	13-25 High

Geophysical Survey Risk Assessment 2 Use of hand tools and survey instruments

Activity	Location	Hazard	Risks	Persons affected	Initial risk	Control measures	Residual risk	Name	Date	Rescue procedures
Surveying, setting out and use of small hand tools and marker canes.	Various.	Splinters from poorly maintained equipment, trip hazards from unused equipment, trip hazards from uneven ground, some heavy lifting, tape winding. **Overhead Power Cables**.	Minor injuries.	All field staff.	8	Ensure all tools in serviceable condition. Careful policing of temporarily unused equipment (e.g. no discarded hand tools, hand tapes pegged down). Ensure all tools and instrumentation carried appropriately.	4	T Schofield	05/02/18	First Aid if required. Call emergency services if necessary.

	Likelihood				
Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Initial Risk
Residual Risk

Likelihood	Severity	Risk (likelihood x severity)
1. Highly unlikely	1. Slight inconvenience	1-5 Low
2. May occur but very rarely	2. Minor injury requiring first aid	
3. Does occur but only rarely	3. Medical attention required	6-12 Medium
4. Occurs from time to time	4. Major injury leading to hospitalisation	
5. Likely to occur often	5. Fatality or serious injury leading to disablement	13-25 High

Suffolk Archaeology CIC
Unit 5 | Plot 11 | Maitland Road | Lion Barn Industrial Estate
Needham Market | Suffolk | IP6 8NZ

Rhodri.Gardner@suffolkarchaeology.co.uk
01449 900120

www.suffolkarchaeology.co.uk

www.facebook.com/SuffolkArchCIC

www.twitter.com/suffolkarchcic