Land at Stalham Road, Hoveton, Norfolk

Geophysical Survey Report

Produced for Suffolk County Council

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Mapping Our Heritage

Non-Technical Summary

Magnetic survey was commissioned to prospect for possible structures of archaeological interest in advance of proposed development.

Very little was found and much of the magnetic character of the site could be related to natural geological processes and relatively modern activity. However, slight signs were found of what might be an earlier field system and in addition a large buried earthwork beneath the northern part of the site. The interpretation of this is uncertain; it could be a palaeochannel, however, the abrupt changes in orientation might suggest a (partly?) artificial origin.

Digital Data

Data	Included?	Format
Survey outlines	Yes	Vector: AutoCAD R12 DXF
Interpretation	Yes	Vector: AutoCAD R12 DXF
XY Traces		Vector: AutoCAD R12 DXF
Contours		Vector: AutoCAD R12 DXF
Images		Georeferenced raster: GeoTIFF
Catalogue		Database: MS Access 2003

Media	Sent to	Date
E-mail	Jo Caruth	14th June 2011

Audit

Version	Author	Checked	Date
Draft Final	MJR	ACKR	9th June 2011
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1 Introduction

Overview

1.1 ArchaeoPhysica was commissioned by Suffolk County Council to provide magnetic survey to prospect for possible structures of archaeological interest across two fields north of Hoveton.

1.2 Norfolk Historic Environment Service set a brief for the works which specifies methodology and relevant standards and guidance (Albone, 2010).

Location

Country	England
County	Norfolk
Nearest Town	Hoveton
Central Co-ordinates	631140 318940

1.3 The survey covered an area of approximately 7.2 ha across two fields adjacent to Stalham Road.

Constraints and variations

1.4 No constraints were encountered and no variations were necessary. All works were conducted according to ArchaeoPhysica's specification (Roseveare, 2011).

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2 Context

Archaeology

2.1 The following text is quoted verbatim from the brief (Albone, 2010):

"An archaeological desk-based assessment for the proposed development site indicates that is it is largely unknown archaeological potential. However, cropmarks of Roman field systems recorded to the west of the site may continue into this area."

Environment

Superficial 1:50000 BGS	Happisburgh Glacigenic Formation – Sand and Gravel (HPGL, BGS 1:50,000)
Bedrock 1:50000 BGS	Crag Group Sand and Gravel (CRAG BGS 1:50,000)
Topography	Flat
Hydrology	Probably natural drainage
Current Land Use	Agricultural (arable)
Historic Land Use	Mixed agricultural
Vegetation Cover	Emergent crop
Sources of Interference	Traffic on adjacent roads

2.2 The geological CRAG group with its widest definition is a marine deposit formed by the accumulation of gravel derived from rocks in the Midlands and Wales. Where silt components exist it is coloured green by glaucomite, an iron potassium mica that forms in reducing conditions in sediments. Where this material is exposed to air it will oxidise to orange haematite.

2.3 It is thought to be buried at this site beneath the Happisburgh deposits, loosely a flinty and quartzy till, differentiated by these constituents from other glacial tills further south in East Anglia. If this is the case, the magnetic properties of the CRAG group will not be relevant as buried at too great a depth, however, the site is close to the edge of the Happisburgh deposits and hence some degree of uncertainty exists.

2.4 If the CRAG deposits, classified at this location by the BGS as sands and gravels, contain glaucomite then the potential for strong magnetic susceptibility enhancement exists as surface deposits will have weathered to haematite which is then available for conversion within hearths (for example) to magnetic maghaemite, detectable by a magnetometer. However, natural processes and especially a fluctuating water table may also facilitate both this conversion and also conversion from glaucomite to more magnetic forms of iron.

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3 Methodology

Objective

3.1 The basic objective is to detect and define the extent of buried structures of archaeological interest within the constraints imposed by the specified method. The resolution must be such that structures perhaps only 0.5m wide or diameter have a chance of being detected and that the anomalous field from them is sufficiently sampled so as to permit analysis of characteristics potentially diagnostic of different materials and structures.

3.2 The totality of the site should be examined in detail.

Survey

Hardware

Measured Variable	Total magnetic field / nT
Instrument	2 x Geometrics G858 MagMapper magnetometers (array)
Configuration	Transverse non-gradiometric array, sledge mounted
Sensitivity	0.03nT @ 10 Hz
QA Procedure	Continuous observation
Resolution	1.0m cross line, 0.25m (mean) along line

Monitoring and quality assurance

3.3 The system continuously displays all incoming data as well as line speed and spatial data resolution per acquisition channel during survey. Rest mode system noise is therefore easy to inspect simply by pausing during survey and the continuous display makes monitoring for quality intrinsic to the process of undertaking a survey.

3.4 An area of repeated survey was undertaken within the central part of the eastern field. This is imaged in DWG 04, overlaid upon the main survey. As expected, there are no significant differences between the two.

3.5 A suitably qualified Project Geophysicist was in the field at all times and fieldwork and technical considerations were guided by the Senior Geophysicist.

Processing

Procedure

3.6 All data processing is minimised and limited to what is essential for the class of data being collected, e.g. reduction of orientation effects from magnetic sensors, suppression of single point defects (drop-outs or spikes), etc. The process stream for this data is as follows:

Process	Software	Parameters
Measurement and GNSS receiver data alignment	Proprietary	
Heading reduction	Proprietary	
Gridding	Surfer	Kriging, 2m window, 0.25 x 0.25m grid
Reduction of regional field	Proprietary highpass filter	300m 3rd order Butterworth
Pseudogradient calculation	Proprietary	1.0m
Imaging and presentation	Manifold GIS	

3.7 The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Surfer is used for gridding and initial study before the data is ported as data surfaces (not images) into Manifold GIS for final imaging and detailed analysis. Specialist analysis is undertaken using proprietary software.

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3.8 General information on processes commonly applied to data can be found in standard text books and also in the 2008 English Heritage Guidelines "*Geophysical Survey in Archaeological Field Evaluation*" at http://www.helm.org.uk/upload/pdf/Geophysical_LoRes.pdf.

3.9 ArchaeoPhysica uses more advanced processing for magnetic data using potential field techniques standard to near-surface geophysics. Details of these can be found in Blakely, 1996, "*Potential Theory in Gravity and Magnetic Applications*", Cambridge University Press.

3.10 All archived data includes process metadata.

Interpretive framework

Resources

3.11 Numerous sources are used in the interpretive process which takes into account shallow geological conditions, past and present land use, drainage, weather before and during survey, topography and any previous knowledge about the site and the surrounding area. Old Ordnance Survey mapping is consulted and also older sources if available.

Magnetic survey

3.12 Interpretative logic is based on structural class and examples are given below. For example a linear field or gradient enhancement defining an enclosed or semi-enclosed shape is likely to be a ditch fill, if there is no evidence for accumulation of susceptible material against a non-magnetic structure. Weakly dipolar discrete anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and *in-situ* hearths can produce similar anomalies. Reduced field strength (or gradient) linear anomalies without pronounced dipolar form are likely to be caused by relatively low susceptibility materials, e.g. masonry walls, stony banks or stony or sandy ditch fills.

Standards & guidance

3.13 All work was conducted in accordance with the following standards and guidance:

- David et al, "Geophysical Survey in Archaeological Field Evaluation", English Heritage 2008
- "Standard and Guidance for Archaeological Field Evaluation", Institute for Archaeologists 2008.

3.14 Archive formation is in the spirit of the following document which is, however, dated and not of direct relevance to the form and structure of data collected during non-gridded multi-sensor survey:

- Schmidt, A. et al, 2001, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS

3.15 In addition, all work is undertaken in accordance with the high professional standards and technical competence expected by the Geological Society of London and the European Association of Geoscientists and Engineers.

3.16 All personnel are experienced surveyors trained to use the equipment in accordance with the manufacturer's expectations. All aspects of the work are monitored and directed by fully qualified professional geophysicists.

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4 Catalogue

4.1 The numbers in square brackets in this report refer to the catalogue below and DWG 03.

Label	Anomaly Type	Feature Type	Description	Easting	Northing
1	Weak dipolar enhanced linear	Fill - Ditch	Probable ditch fill less than 1m wide, perhaps a former field boundary or part of a former field system. See also [2]	631041.7	318987.9
2	Weak dipolar enhanced linear	Fill - Ditch	See [1] which is parallel and about 43m to the north	631024.2	318945.8
3	Weak enhanced linear	Fill? - Ditch?	A very weak anomaly of variable contrast may continue the line of [1] eastwards but this is by no means certain	631123.4	318957.7
4	Weak enhanced linear	Fill? - Ditch?	A weak linear anomaly hints at the presence of other filled features that are not contributing measurable magnetic anomalies	631052.8	318927.1
5	Weak dipolar enhanced linear	Fill - Ditch	A linear anomaly, most likely a ditch fill and probably a former field boundary	631187.7	318918.4
6	Weak dipolar enhanced linear	Fill / discontinuity - Natural?	A broad diffuse anomaly typical of a deeply buried structure, probably natural in origin. A lateral discontinuity in the Happisburgh sand and gravel is a possibility as this is known to be discontinuous in the locality	631159.6	319012.9
7	Weak dipolar enhanced linear	Fill / discontinuity - Natural?	See [6] which may be due to the same underlying structure as [7]	631123.0	319062.1
8	Strong dipolar	Ferrous - Structure?	One of a pair (with [9]) of three grouped ferromagnetic anomalies on the same line as but not connected with the OHC, perhaps the remains of an earlier installation	631238.5	318981.1
9	Strong dipolar	Ferrous - Structure?	See [8]	631125.0	318888.6
10	Contamination	N/A	Not significant - processing artefact due to process instability induced by nearby strong magnetic contamination	631000.0	318865.2
11	Contamination	N/A	See [10]	631181.8	318860.5

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5 Discussion

Introduction

5.1 The sections below first discuss the geophysical context within which the results need to be considered and then specific features or anomalies of particular interest. Not all will be discussed here and the reader is advised to consult the catalogue (*ibid*) in conjunction with the graphical elements of this report.

Principles

5.2 In general, topsoil is more magnetic than subsoil which can be slightly more magnetic than parent geology, whether sands, gravels or clays, however, there are exceptions to this. The reasons for this are natural and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

5.3 Within landscapes soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

5.4 As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures which would not be detected unless magnetic in their own right, *e.g.* built of brick or tile. As a prospecting tool it is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity and it is nearly always the case that cut features will alter in some way the local magnetic field.

Instrumentation

5.5 The use of the magnetic sensors in non-gradiometric (vertical) configuration avoids measurement sensitisation to the shallowest region of the soil, allowing deeper structures, whether natural or otherwise to be imaged within the sensitivity of the instrumentation. However, this does remove suppression of ambient noise and temporal trends which have to be suppressed later during processing. When compared to vertical gradiometers in archaeological use, there is no significant reduction in lateral resolution when using non-gradiometric sensor arrays and the inability of gradiometers to detect laminar structures is completely avoided.

5.6 Caesium instrumentation has a greater sensitivity than fluxgate instruments, however, at the 10 Hz sampling rate used here this increase in sensitivity is limited to about one order of magnitude.

5.7 The array system is designed to be non-magnetic and to contribute virtually nothing to the magnetic measurement, whether through direct interference or through motion noise. There is, however, some limited contribution from the towing ATV and especially during strong changes in system geometry, e.g. when turning a corner.

Character & principal results

5.8 For detailed comment the reader is advised to consult the catalogue in section four, above.

5.9 The data has a fairly uniform character but with a strong striation from recent cultivation and interference from adjacent residential and other boundaries. In the south eastern part of the survey this has led to a slight artefact from processing during the application of a system heading correction.

5.10 There is a weak irregular variation across the entire survey with a character typical of relatively deep structural / chemical variation and likely to be due to the underlying sand and

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gravel. If there is glaucomite within this material partial and variable oxidation of this mineral produce this subtly variable magnetic texture.

5.11 Some narrow probable ditch fills [1] – [2] and perhaps [5] may hint at the remains of a former field system although this is not certain. These are all apparently constrained by the present field boundary between the two fields.

5.12 Structure [5] appears to be associated with a weaker parallel possible fill [4], perhaps the remains of a wide cultivation headland or another ditch? In the western field, a weak anomaly [4] also hints at additional structure, however, too little is visible to be certain and a natural origin is possible.

5.13 A pair of very weak broad enhanced field anomalies [6] and [7] hint at a palaeochannel or similar structure buried fairly deeply beneath the site. An alternative interpretation might be some sort of wartime defensive structure because the changes in alignment are very abrupt, perhaps suggesting an artificial aspect to their formation?

5.14 Two groups [8] and [9] of three strongly magnetic anomalies suggest something has been removed from the field. Their alignment beneath an existing overhead cable may be significant, however, why there should be three anomalies at each location is unclear.

Conclusions

5.15 Very little of obvious interest to the archaeologist has been revealed by the survey and what features are evident are only weakly magnetic.

5.16 The most unexpected discovery is the possible palaeochannel or similar large buried structure. Its size means that only more extensive survey is likely to inform upon its true nature and origin.

Caveats

5.17 Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to archaeological features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or 'anomaly', is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

5.18 The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

5.19 Where the specification is by a third party ArchaeoPhysica will always endeavour to produce the best possible result within any imposed constraints and any perceived failure of the specification remains the responsibility of that third party.

5.20 Where third party sources are used in interpretation or analysis ArchaeoPhysica will endeavour to verify their accuracy within reasonable limits but responsibility for any errors or omissions remains with the originator.

5.21 Any recommendations are made based upon the skills and experience of staff at ArchaeoPhysica and the information available to them at the time. ArchaeoPhysica is not responsible for the manner in which these may or may not be carried out, nor for any matters arising from the same.

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Bibliography

Albone, A., 2010, "*Brief for archaeological evaluation by geophysical survey of land at Stalham Road, Hoveton, Norfolk*", HES Reference CNF43199, unpublished

BGS 1:50,000 mapping of bedrock and superficial deposits

BGS Lexicon of rock units

Roseveare, 2011, "*Land at Stalham Road, Hoveton, Norfolk – Specification for Geophysical Survey*", ArchaeoPhysica, unpublished

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Appendices

Survey metadata

Project information

Project Name	Hoveton, Norfolk
Project Code	HVN111
Norfolk CC ENF	126712
OASIS	suffolkc1-102997
Client	Suffolk County Council
Fieldwork Dates	30th March 2011
Field Personnel	ACK Roseveare, T Bellomo
Processing Personnel	ACK Roseveare MJ Roseveare
Reporting Personnel	MJ Roseveare
Draft Report Date	9th June 2011
Final Report Date	14th June 2011

Qualifications & experience

5.22 All work is undertaken by qualified and experienced geophysicists who have specialised in the detection and mapping of near surface structures in archaeology and other disciplines using a wide variety of techniques. There is always a geophysicist qualified to post-graduate level on site during fieldwork and all processing and interpretation is undertaken under the direct influence of either the same individual or someone of similar qualifications and experience.

5.23 ArchaeoPhysica meets with ease the requirements of English Heritage in their 2008 Guidance "Geophysical Survey in Archaeological Field Evaluation" section 2.8 entitled "Competence of survey personnel". The company is one of the most experienced in European archaeological prospection and is a key professional player. It only employs people with recognised geoscience qualifications and capable of becoming Fellows of the Geological Society of London, the Chartered UK body for geophysicists and geologists.

Safety

5.24 Safety procedures follow the recommendations of SCAUM (now FAME) & the IAGC (International Association of Geophysical Contractors).

5.25 Principal personnel have passed the Rescue Emergency Care – Emergency First Aid course and CSCS cards are being sought for those members of staff currently without them.

5.26 All personnel are issued with appropriate PPE and receive training in its use. On all sites health and safety management is performed by the Project Geophysicist under supervision by the Operations Manager. A preliminary risk assessment will be prepared and made available to interested parties upon award of tender.

5.27 Health and safety policy documentation is reviewed every 12 months, or sooner if there is a change in UK legislation, a reported breach of such legislation, a reported Incident or Near Miss, or changes to ArchaeoPhysica's activities. Anne Roseveare, Operations Manager, has overall responsibility for conducting this review and ensuring documentation is maintained.

5.28 We are happy to confirm that ArchaeoPhysica has suffered no reportable accidents since its inception in 1998.

Archiving

5.29 ArchaeoPhysica maintains an archive for all its projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by ArchaeoPhysica on

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all material it has produced, the client having full licence to use such material as benefits their project.

5.30 Access is by appointment only. Some content is restricted and not available to third parties. There is no automatic right of access to this archive by members of the public. Some material retains commercial value and a charge may be made for its use. An administrative charge may be made for some enquiries, depending upon the exact nature of the request.

5.31 The archive contains all survey and project data, communications, field notes, reports and other related material including copies of third party data (e.g. CAD mapping, etc) in digital form. Many are in proprietary formats while report components are available in PDF format.

5.32 In addition, there are paper elements to some project archives, usually provided by the client. Nearly all elements of the archive that are generated by ArchaeoPhysica are digital.

5.33 It is the client's responsibility to ensure that reports are distributed to all parties with a necessary interest in the project, e.g. local government offices, including the HER where present. ArchaeoPhysica reserves the right to display data from projects on its website and in other marketing or research publications, usually with the consent of the client. Information that might locate the project is normally removed unless otherwise authorised by the client.

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working for

Suffolk County Council

Magnetic Survey
Approximate extent

Hoveton
Norfolk

HVN111

DWG 01

Site Location

Orthographic - Scale: 1:10000 @ A3
Spatial Units: Meter. Do not scale off this drawing

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Suffolk County Council

Magnetic Data
1.0m Pseudogradient nT/m
5
0
-5

Hoveton
Norfolk

HVN111

DWG 02

Magnetic Data
1.0m Pseudogradient

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Catalogue
Points
text Labels
Area enhanced
Extent
Linear enhanced
Fill extent
Weak / conjectured
Ferrous
Extent
Services
Approximate line
OHC Poles

Hoveton
Norfolk

HVN111

DWG 03

Catalogue

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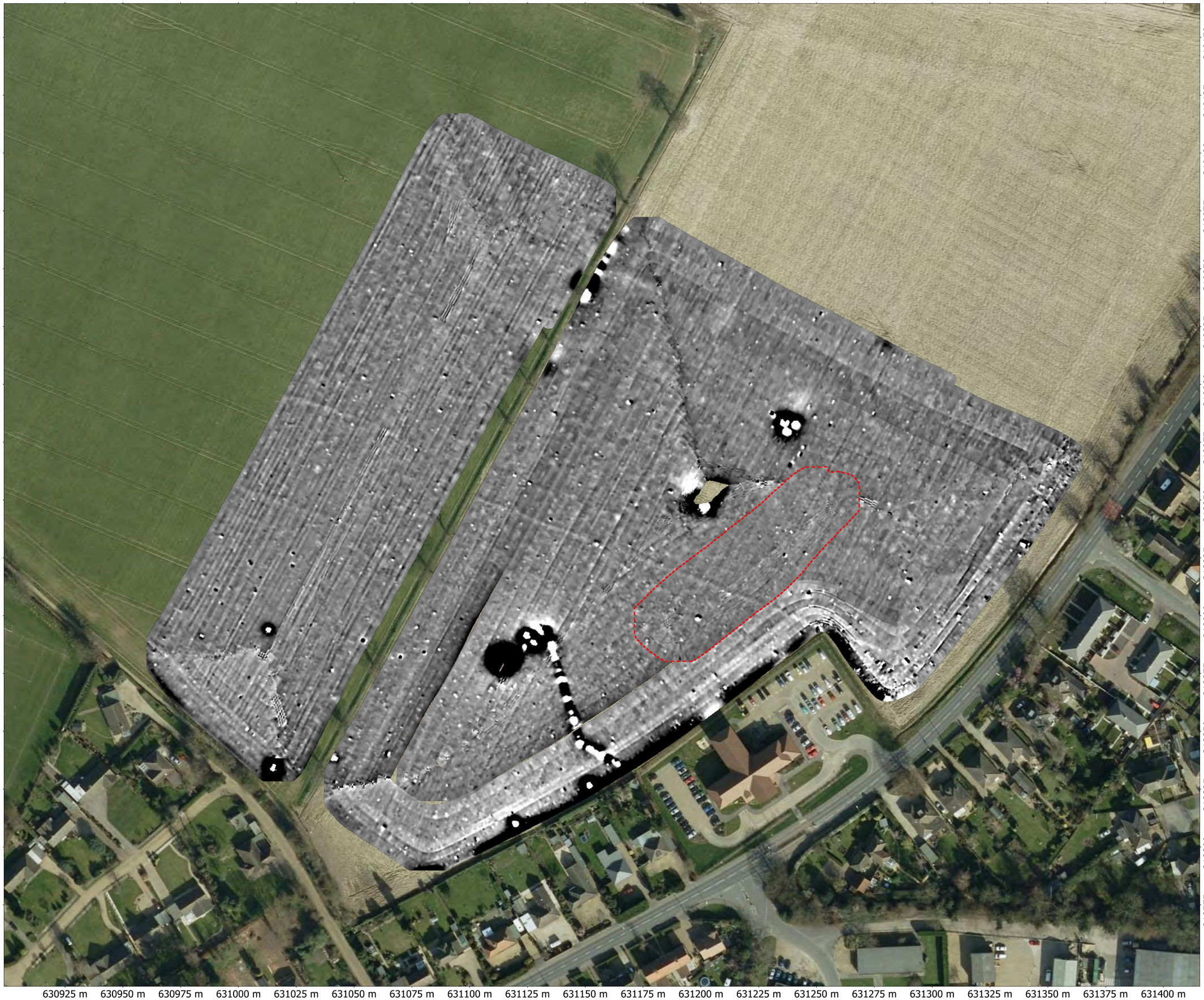

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Magnetic Data

1.0m Pseudogradient nT/m

5

0

-5

Repeated Area

Edge of repeat survey

Hoveton
Norfolk

HVN111

DWG 04

Magnetic Test Data
Repeated Area (Outlined)

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Suffolk County Council

Magnetic Data

East field / nT

48928

48918

48908

West field / nT

48936

48926

48916

Hoveton
Norfolk

HVN111

DWG 05

Magnetic Data
As Collected

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