TIGERGEO

Land at Aldham Mill Hill, Hadleigh, Suffolk

Geophysical Survey Report
(Caesium Vapour Magnetic – Archaeology)

Version 1.1

Project code: AMH171

HER Parish No: HAD 160

OASIS: tigergeo1-304047

Produced for:

CgMs Limited (Part of the RPS Group)

Authors:

MJ Roseveare, Senior Geophysicist

BSc(Hons) MSc MEAGE FGS MCIfA

REGISTERED CIfA ORGANISATION

7th February 2018

Environmental Geophysics – Survey, Research and Consultancy

TIGERGEO

Land at Aldham Mill Hill, Hadleigh, Suffolk

Digital data

Item and version	Sent to	Sent date
CAD – Vector Elements 1.0	Manca Petric	18th January 2018

Audit

Version	Author	Checked	Date
Interim			
1	MJ Roseveare	ACK Roseveare	18th January 2018
1.1		D Lewis	7th February 2018

Project metadata

Project Code	AMH171
Client	CgMs Limited (Part of the RPS Group)
Fieldwork Dates	10th - 11th January, 2018
Field Personnel	J Wild, J Almendros
Data Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare, D Lewis
Report Date	7th February 2018
Report Version	1.1

TigerGeo Limited

TigerGeo Limited - Registered in England & Wales 09895326 - D-U-N-S 22-127-7456
Registered Office: 2 Wyevale Business Park, Kings Acre, Hereford, Herefordshire HR4 7BS UK
+44 (0) 1989 730 564 – www.tigergeo.com - @TigerGeoUK – also on LinkedIn & Facebook

Non-Technical Summary

A magnetic survey was commissioned by CgMs Limited (Part of the RPS Group) to prospect land at Aldham Mill Hill, Hadleigh, Suffolk, for buried structures of archaeological interest. Survey was undertaken using an ATV-towed and GNSS-tracked non-gradiometric array of caesium vapour magnetometers on a non-magnetic platform.

Two clear and large likely Bronze Age funerary monuments with multiple encircling ditches and internal features are present in the southern part of the site and were expected from cropmark evidence and other examples found just beyond the survey. A third Bronze Age funerary monument, also expected from cropmark evidence, is less obvious and a smaller cropmark, to the north, has not been detected.

North of these funerary monuments a large Roman era enclosure has been found and is likely to have included a contemporary farming settlement although this has not been seen in the data. There is possible, although ambiguous, evidence for Iron Age or later funerary activity, including a small square enclosure. A number of linear ditch fills and a possible track or similar structure might indicate the former presence of former field systems lost prior to the 1880s Ordnance Survey mapping.

Table of Contents

TIGERGEO

Drawing	**Title**
DWG 05	Interpretation – Vector Only

1 Introduction

TigerGeo was commissioned by CgMs Limited (Part of the RPS Group) to undertake a geophysical survey of land at Aldham Mill Hill, Hadleigh, Suffolk. Survey was undertaken using an array of caesium vapour magnetometers to prospect for buried features possibly of archaeological interest.

Complete coverage of the single field was achieved.

Country	England
County	Suffolk
Nearest Settlement	Hadleigh
Central Co-ordinates	602460, 243413
Survey area	~8 ha

2 Context

2.1 Environment

Soilscapes Classification	Freely draining slightly acid loamy soils (6)
Superficial 1:50000 BGS	River Terrace deposits, 2 – Sand and Gravel (RTD2), Alluvium – Clay and Silt (ALV) adjacent to the river
Bedrock 1:50000 BGS	Newhaven Chalk Formation (NCK)
Topography	Flat
Hydrology	Potentially high water table with River Brett forming western boundary
Current Land Use	Agricultural – young crop
Historic Land Use	Agricultural - mixed
Vegetation Cover	Grass and weedy vegetation
Sources of Interference	Vehicular movement along roads to the north and east

2.1.1 Geology, soil and site description

The soil classification is the same across the proposed survey area, although seasonal wet areas, adjacent to the river, may exhibit slightly different soil properties. Alluvial deposits are recorded next to the river, with river terrace deposits over the rest of the site, but the boundary of these two superficial geologies may be indistinct.

The natural magnetic properties can be expected to vary with the composition of these deposits, and with the potential increased magnetic susceptibility in the vicinity of former human activity, e.g. settlement. The British Geological Survey (BGS) G-Base data records soil iron concentration as only 1.8% (5km resolution) within a regional figure of 2.5% and these are both low.

The survey area was open and recently planted with crop. The northern end is bounded by the Hadleigh by-pass and the eastern edge by a road and residential development. The River Brett forms the western boundary to the site. Some localised ferrous effects are expected from the roads but there are no overhead services known to cross the site.

2.2 Heritage

The proposed survey area has previously been subject to desk-based assessment (CgMs, 2017). The summary of the assessment states that:

"The study site is considered to have a known archaeological potential for Bronze Age and Medieval evidence, a moderate to high archaeological potential for Iron Age and Roman evidence, a moderate archaeological potential for Early Prehistoric, Neolithic and Anglo-Saxon evidence and a low archaeological potential for Post-Medieval evidence.

Any Early Prehistoric, Bronze Age, Roman or Saxon remains could be regionally significant. Any other archaeological remains are expected to be locally significant."

Historic aerial photographs of the site (ref HAD 015_SAU_23) reveal a series of cropmarks of potential archaeological interest. In the southern half of the site a series of four circular features (MSF5182, MSF5181, MSF5180 and MSF5179) are visible, with the central two cropmarks the most distinct. In the north, a large rectangular cropmark enclosure (MSF 5157) extends beyond the north-east, within this a smaller square-shaped enclosure is also visible (MSF5194).

Historic maps in the above assessment suggest that, with the exception of the northern boundary, the morphology of the proposed survey area has changed little since the early 19th century.

3 Discussion

3.1 Character & Principal Results

3.1.1 Introduction

The following paragraphs represent an interpretive summary of the survey. The numbers in square brackets refer to individual anomalies described in detail in the catalogue below and shown on DWG 04 onwards.

3.1.2 Data

Data quality is overall good with little survey noise but with the expected magnetic contamination from the traffic on the road adjacent to the eastern site boundary. Fairly recent cultivation has helped to create a fairly strong grain to the data along the length of the field but the effects of this are mostly cosmetic.

Magnetic contrast is reasonable (see comment below about soil iron concentration) and the background texture is naturally variable across the site. Anomaly strength from features of archaeological interest is variable, ranging from 10 nT (3 nT/m pseudogradient) in association with some of the Roman era ditch fills to less than 1 nT (< 1 nT/m pseudogradient) from fills of some funerary monuments.

In contrast, anomalies from some natural sources exceed 50 nT (20 nT/m pseudogradient) in places and are everywhere of at least similar magnitude to those from features of archaeological interest.

3.1.3 Geology

Despite the reported soil iron concentration being low according to the BGS G-Base data, magnetic contrast is actually quite reasonable, most likely due to the low variation within the background texture away from former fluvial structures. There is also a functional element within the apparent contrast; funerary structures [24] and [26] are associated with the weakest anomalies, whereas cultivation and probably also settlement activity have augmented magnetic susceptibility and hence contrast in connection with the Roman era structures [2] and [3].

The western edge of the site is dominated by past fluvial activity with the eroded edge of River Terrace Deposits apparent at [15] and alluvium present west of this. Further channel edges are apparent at [18] and [19] where they are particularly magnetic, likely due to depositional processes, which itself implies the natural presence of materials of appreciable magnetic susceptibility, albeit maybe imported by fluvial activity.

An interaction between these fluvial processes and features of archaeological interest seems to be apparent at the southern ends of [4] and [5] where these may be cut by channel edge [19].

There is an interpretive ambiguity at the site in the form of the group of discrete anomalies [14] which could be interpreted in two ways. River Terrace Deposits can be associated with numerous discrete magnetic sources in the form of magnetic erratics within gravel and this can crate the speckled appearance evident at this site. The apparent localisation of these anomalies would not be expected in this context although it is not geologically impossible if, for example, soil depth or an alluvial deposit increased in thickness eastwards. There are also a number of discrete anomalies of larger (plan) size than would be expected from erratics within gravel and therefore there is increased potential for pit fill type features to exist, natural or otherwise.

However, the ambiguity is that an area of artificial pit fills or small hearths or larger ceramic objects could create similar anomalies and given the nearby presence of funerary structures and also the small enclosure [12] there is an enhanced possibility of this being the origin of at least some of these anomalies.

This being the case, although in this geological context discrete anomalies [20], [21] and [22] could be natural, they might not be and hence caution in their interpretation is advised.

3.1.4 Land use

There is little OS map evidence for former field boundaries but some anomalies at the site may represent elements within former field systems. In the southern part of the site strongly reduced intensity anomalies [27] and [28] are unusual and typical of materials less magnetic than the soil, e.g. masonry, voids or deep peaty fills. Given their location, it seems likely that these reflect former field boundaries although are unlikely to be the boundaries themselves and might instead be former tracks or similar constructed features.

Further north, both [11] and [13] could be former enclosure boundaries, presumably of a field system wholly removed prior to the 1880s. They appear to respect each other and are both clearly of a different phase to other features at the site.

A group of isolated linear anomalies [10] is slightly ambiguous but could be field drains whereas the long examples [16], [17] and [23] seem more obviously likely to be drainage structures.

At the southern tip of the site a large area of magnetic debris [29] may reflect modern hardcore imported to the site or alternatively material from a small demolished building.

3.1.5 Archaeology

The most striking feature is a large probable Roman era agricultural establishment defined by a large parallelogram shaped enclosure ([1], [2] and [3]). This has previously been identified by aerial photographs and recorded on the Suffolk Historic Environment Record as (MSF 5157). The results of the survey add detail to the record, with an entrance evident in the southern side. An access 15m wide and defined by parallel ditches [4] and [5] extends from this towards the river with its end apparently lost through past fluvial erosion [19]. It is likely that the enclosure contains the remains of contemporary settlement (on magnetic as well as functional grounds) although this was not seen within the data. The alignment of [4] and [5] is continued into the enclosure in a differently magnetic form and towards the centre where these anomalies cease; this might be evidence for where a focus of activity should be sought. Further probable ditch fills [7], [8], [9] are close to this location but are not obviously related. The fills of the ditches [4] and [5] internal to the enclosure are less magnetic than those outside which suggests that within the interior of the enclosure there have been activities of the sort to augment magnetic susceptibility, e.g. cultivation, settlement or industry.

The two linear anomalies [11] and [13], typical of ditch fills but of a different phase from the probable Roman era enclosure are thought to perhaps be former field boundaries, however, there is no corroborative evidence for this.

Of a different phase again, overlapping or being overlapped by [2] and [11], is another previously identified cropmark (MSF5194); a small square enclosure [12] reminiscent of something sometimes seen in prehistoric funerary contexts. In this regard, the nearby group [14] of discrete anomalies may also be relevant. As discussed above, they may be natural but their concentration, character and the presence of the square enclosure [12] combined means the possibility of a scatter of pits, hearths or ceramics cannot in this case be discounted and hence their interpretation is ambiguous.

Out of the other groups of pit fill like features, [22] seems the most likely to be artificial from examples [20], [21] and [22]. Again, their interpretation is slightly ambiguous given the presence of [14].

Prominent in the southern part of the survey, in an area of previously identified circular cropmarks (MSF5182, MSF5181, MSF5180 and MSF5179), are two large probable Bronze Age funerary monuments [24] and [26]. The northern [24], has a well defined outer circular ditch fill and within this a less clear inner circle of ditch or perhaps pit fills and at the centre of the monument there is a small discrete anomaly that might be a central feature. To the north of the centre some other discrete anomalies may be associated, if they are not simply part of the continuum of such anomalies that extend across the site overall.

The southern example, [26], is of different form with a strongly magnetic inner ditch fill encircled by a weaker one. Again there is a possible central feature and here, between the two circuits of ditch fill there appear to be several small discrete anomalies that might represent pits or hearths, or perhaps later burials inserted into the monument. A third example [30] is less clear, with part of a circular ditch evident in an area of geological banding.

3.2 Catalogue

Label	Anomaly Type	Feature Type	Description
1	Linear enhanced intensity	Fill - Ditch	The northern limb of a parallelogram or trapezoidal enclosure measuring about 170m NS and at least 120m EW (the eastern edge was not seen in the data). The magnetic component of the fill measures about 1.6m wide. See also [2] – [5] (MSF 5157)
2	Linear enhanced intensity	Fill - Ditch	The western edge of the same enclosure as [1], ending at a probable gateway in the southern limb (MSF 5157)
3	Linear enhanced intensity	Fill - Ditch	The southeast limb of the same enclosure as [1] and [2] (MSF 5157)
4	Linear enhanced intensity	Fill - Ditch	One of a pair (with [5]) of long ditch fills flanking an entrance into the enclosure defined by [1] – [3]. They are about 15m apart and their line is continued inside the enclosure by further ditches up to 70m long. Outside the enclosure they are at least 115m long, their southern ends lost in strong magnetic anomalies associated with a former river bank
5	Linear enhanced intensity	Fill - Ditch	See [4]
6	Linear enhanced intensity	Fill – Ditch / natural?	Uncertain, may be a ditch fill
7	Linear enhanced intensity	Fill? – Ditch?	One of several linear fills that might be parts of enclosures or could relate to drains; the anomalies are too weak to be more diagnostic
8	Linear enhanced intensity	Fill? - Ditch?	See [7]
9	Linear enhanced intensity	Fill? - Ditch?	See [7]
10	Linear enhanced intensity (group)	Fills – Ditches / drains?	See [7], although these look more like field drains
11	Linear enhanced intensity	Fill - Ditch	A linear ditch fill 244m long and apparently respected by another [13] approaching from the west. Although both may be former field boundaries, they had been removed prior to the 1880s OS map edition
12	Linear enhanced intensity (group)	Fills - Ditches	A small square enclosure of about 12.5m side length and of different date from the enclosure defined by fills [1] – [3] and also [12], both of which cross the enclosure (MSF5194)
13	Linear enhanced intensity	Fill - Ditch	A zigzagging linear fill that is of the same phase as [11], see above
14	Discrete enhanced intensity (group)	Fills / geological – Pits / hearths / natural	Interpretation of these is difficult: they are similar to anomalies typical of some River Terrace Deposits (RTD) and are caused by magnetic erratics and natural silty pockets in the top of gravel. What makes these slightly different is their size (amplitude and lateral) which are both slightly greater than might be expected from RTD. If they are not natural then individual pits or small hearths may be an explanation. The plotted examples are a subset after sorting by size, amplitude and anomaly character and should not be considered a definitive map
15	Linear enhanced intensity (group)	Natural	Eroded western edge of River Terrace Deposits, west of which is alluvium
16	Linear enhanced intensity	Fill – Ditch / drain?	Probable drain, although manifest as a ditch fill type anomaly

Label	Anomaly Type	Feature Type	Description
17	Linear enhanced intensity	Fill – Ditch / drain?	Probable drain, although manifest as a ditch fill type anomaly
18	Linear enhanced intensity (group)	Natural	Eroded edge within River Terrace Deposits, one of several former fluvial structures below this part of the field
19	Linear enhanced intensity (group)	Natural	See [18]. In this case the apparent loss of fills [4] and [5] at this erosion feature is of chronological interest
20	Discrete enhanced intensity (group)	Fills – Pits / natural?	Uncertain; without the complexity of [12] and [14] these could be interpreted as natural fills
21	Discrete enhanced intensity (group)	Fills – Pits / natural?	See [20]
22	Discrete enhanced intensity (group)	Fills – Pits / natural?	See [20]
23	Linear enhanced intensity	Fill – Ditch / drain?	Probable drain, although manifest as a ditch fill type anomaly
24	Linear enhanced intensity (group)	Fills – Ring ditches	A 30m diameter ring ditch typical of a prehistoric funerary monument. The are weak signs of a concentric internal ditch or post ring of 24m diameter. Some strong discrete anomalies within this might mark internal structure and there is a small ferrous type anomaly at the centre itself (MSF 5180)
25	Linear enhanced intensity	Fill - Ditch	Uncertain but probably a hybrid of [26] and some other feature, apparently replacing the northwest arc of the ring
26	Linear enhanced intensity (group)	Fills – Ring ditches	A complex monument comprising two concentric ditch fills of 13m and 26m diameter, the inner apparently slightly wider. At the centre there is a small discrete anomaly and between the two rings there are several small discrete anomalies that could be individual pits or ceramic material (MSF5181)
27	Linear strongly reduced intensity	Structure / fill	A strongly reduced magnetic intensity linear anomaly up to 2.5m wide and typically a non-magnetic material like air, sand, gravel or masonry or a diamagnetic fill like peat. Old OS map editions show a field boundary in this approximate location but not a structure with the layout evident in the data
28	Linear strongly reduced intensity	Structure / fill	See [27]
29	Texture	Debris	Typical of mixed brick, tile and / or ferrous materials, may be related to nearby modern construction or to demolition of a small building
30	Linear enhanced intensity	Fill – Ring Ditch?	Uncertain, possible a ring ditch of similar (archaeological) form to [24] and [26] (MSF5182)

3.3 Conclusions

The western part of the site is dominated by past fluvial activity that appears to have interacted with features of archaeological interest in this part of the site, e.g. the entrance structure into the probable Roman era enclosure.

Two large likely Bronze Age funerary monuments with multiple encircling ditches and internal features and a less clear third are present in the southern part of the site and were expected from cropmark evidence and other examples found just beyond the survey. A smaller cropmark to the north was not detected.

A large Roman era enclosure has been found and is likely to have included a contemporary farming settlement although this has not been seen in the data presumably because it used non-magnetic materials or is perhaps located just outside the survey to the east.

Possible unenclosed activity, including a small square enclosure, might together imply Iron Age or post-Roman funerary activity although interpretation of the numerous discrete anomalies is ambiguous due to the geological context of the site.

A number of linear ditch fills and a possible track or similar structure might indicate the former presence of former field systems.

3.4 Caveats

Geophysical survey is reliant upon the detection of anomalous values and patterns in physical properties of the ground, e.g. magnetic, electromagnetic, electrical, elastic, density and others. It does not directly detect underground features and structures and therefore the presence or absence of these within a geophysical interpretation is not a direct indicator of presence or absence in the ground. Specific points to consider are:

- some physical properties are time variant or mutually interdependent with others;
- for a buried feature to be detectable it must produce anomalous values of the physical property being measured;
- any anomaly is only as good as its contrast against background textures and noise within the data.

TigerGeo will always attempt to verify the accuracy and integrity of data it uses within a project but at all times its liability is by necessity limited to its own work and does not extend to third party data and information. Where work is undertaken to another party's specification any perceived failure of that specification to attain its objective remains the responsibility of the originator, TigerGeo meanwhile ensuring any possible shortcomings are addressed within the normal constraints upon resources.

4 Methodology

4.1 Magnetic Principles

4.1.1 Physical concepts

Magnetic survey for any purpose relies upon the generation of a clear magnetic anomaly at the surface, i.e. strong enough to be detected by instrumentation and exhibiting sufficient contrast against background variation to permit diagnostic interpretation. The anomaly itself is dependent upon the chemical properties of a particular volume of ground, its magnetic susceptibility and hence induced magnetic field, the strength of any remanent magnetisation, the shape and orientation of the volume of interest and its depth of burial. Finally the choice and configuration of measurement instrumentation will affect anomaly size and shape.

Sites present a complex mixture of these factors and for some the causative affects are not known. However, depth of burial and size are usually fairly constrained and background susceptibility can be estimated (or measured). The degree of remanent magnetisation is harder to predict and depends on both the natural magnetic properties of the soil and any chemical processes to which it has been subjected. Fortunately heat will raise the susceptibility of most soils and topsoil tends to be more magnetic than subsoil, by volume.

It is hard to draw reliable conclusions about what sort of geology is supportive of magnetic survey as there are many factors involved and in any case magnetic response can vary across geological units as well as being dependent upon post-deposition and erosional processes. In general a relatively non-magnetic parent material contrasting with a magnetisable erosion product, i.e. one which contains iron in the form of oxides and hydroxides, will allow archaeological structures to exhibit strong magnetic contrast against their surroundings and especially if the soil has been heated or subjected to certain processes of fermentation. In the absence of either, magnetic enhancement becomes entirely reliant upon the geochemistry of the soil and enhancement will often be weaker and more variable.

Analysis of the British Geological Survey (BGS) Geochemical Atlas (G-Base) for total soil iron reveals that for England and Wales 50% of the samples (the interquartile range) lie between 1.9% and 3.6% percentage iron with the median at 2.7%.

The principal magnetic iron mineral is the oxide magnetite which sometimes occurs naturally but is more often formed during the heating of soil. Subsequent cooling yields a mixture of this, non-magnetic oxide haematite and another magnetic oxide, maghaemite. Away from sources of heat, other magnetic iron minerals include the sulphides pyrite and greigite while in damp soils complex chemistry involving the hydroxides goethite and lepidocrocite can create strong magnetic anomalies. There are thus a number of different geochemical reaction pathways that can both augment and reduce the magnetic susceptibility of a soil. In addition, this susceptibility may exhibit depositional patterns unrelated to visible stratigraphy.

Most structures of archaeological interest detected by magnetic survey are fills within negative or cut features. Not all fills are magnetic and they can be more magnetic or less magnetic than the surrounding ground. In addition, it is common for fills to exhibit variable magnetic properties through their volume, basal primary silt often being more magnetic than the material above it due to the increased proportion of topsoil within it. However, a fill containing burnt soil may be much more magnetic than this primary silt and sometimes a feature that has contained standing water can produce highly magnetic silts through mechanical depositional processes (depositional remanent magnetisation, DRM).

A third structural factor in the detection of buried structures is the depth of topsoil over the feature. As fills sink, the hollow above accumulates topsoil and hence a structure can be detected not through its own magnetisation but through the locally deeper topsoil above it. The volume of soil required depends upon the magnetic susceptibility of the soil but just a few centimetres are often sufficient. Such a thin deposit can, however, easily be lost through subsequent erosion by natural factors or ploughing.

4.1.2 Instrumentation

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. This also allows the detection of shallow broad variations in magnetic susceptibility that might have archaeological significance. Suppression of ambient noise and temporal trends is reduced and therefore need reduction during processing.

The theoretical slightly reduced lateral resolution inherent to using non-gradiometric sensor arrays is practically not an issue and especially if processing includes a vertical pseudogradient conversion. The non-gradiometric system is thus overall a more capable configuration than the short gradiometers often used for archaeological studies.

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. Greater benefit is obtained from a better signal-to-noise ratio meaning that sub-nanoTesla measurement is more practically achieved.

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.

4.2 Magnetic Survey

4.2.1 Technical equipment

Measured variable	Magnetic flux density / nT (Total Magnetic Intensity / nT after removal of regional trend)
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (4 sensors, ATV towed)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Spatial resolution	1.0m between lines, 0.25m mean along line interval

4.2.2 Monitoring & quality assessment

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. Rest mode test results (static test) are available from the system.

4.3 Magnetic Data Processing

4.3.1 Procedure

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

Process	Software	Parameters
Measurement & GNSS receiver data alignment	Proprietary	
Temporal reduction, regional field suppression	Proprietary	Bandpassed 0.3 – 10.0s
Gridding	Surfer	Kriging, 0.25m x 0.25m
Smoothing	Surfer	Gaussian lowpass 3x3 data (0.75m)
Pseudogradient conversion	Proprietary	1m vertical

Potential field processing procedures are used where possible on gridded data from the above processing, allowing simulation of vertical gradient data, separation of deep and shallow magnetic sources, etc. The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Gridded data is ported as data surfaces (not images) into Manifold GIS for final imaging, contouring and detailed analysis. Specialist analysis is undertaken using proprietary software.

4.4 Magnetic Interpretation

4.4.1 Introduction

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. Geological information (for the UK) is sourced only from British Geological Survey resources and aerial imagery from online sources. LiDAR data is usually sourced from the Environment Agency or other national equivalents, SAR from NASA and other topographic data from original survey.

Information from nearby surveys is consulted to inform upon local data character, variations across soils and near-surface geological contexts. Published data from other surveys may also be used if accompanied by adequate metadata.

Interpretation of magnetic data is undertaken using total intensity data, vertical pseudogradient and where relevant, shallow field, component models in parallel although for clarity only a subset of these may be presented in the report.

4.4.2 The contribution from geology and soils

On some sites, e.g. some gravels and alluvial contexts, there will be anomalies that can obscure those potentially of archaeological interest. They may have a strength equal to or greater than that associated with more relevant sources, e.g. ditch fills, but can normally be differentiated on the basis of anomaly form coupled with geological understanding. Where there is ambiguity, or relevance to the study, these anomalies will be included in this category.

Not all changes in geological context can be detected at the surface, directly or indirectly, but sometimes there will be a difference evident in the geophysical data that can be attributed to a change, e.g. from alluvium to tidal flat deposits, or bedrock to alluvium. In some cases the geophysical difference will not exactly coincide with the geological contact and this is especially the case across transitions in soil type.

Geophysical data varies in character across areas, due to a range of factors including soil chemistry, near surface geology, hydrology and land use past and present. These all contribute to the texture of the data, i.e. a background character against which all other anomalies are measured.

4.4.3 Agricultural inputs

Coherent linear dipolar enhancement of magnetic field strength marking ditch fills, narrow bands of more variable magnetic field or changes in apparent magnetic susceptibility, are all included within the category of former field boundaries if they correlate with those depicted on the Tithe Map or early Ordnance Survey maps. If there is no correlation then these anomaly types are not categorised as a field boundaries.

Banded variations in apparent magnetic susceptibility caused by a variable thickness of topsoil, depositional remanent magnetisation of sediments in furrows or susceptibility enhancement through heating (a by product of burning organic matter like seaweed) tend to indicate past cultivation, whether ridge-based techniques, medieval ridge and furrow or post medieval 'lazy beds'. Modern cultivation, e.g. recent ploughing, is not included.

In some cases it is possible to identify drainage networks either as ditch-fill type anomalies (typically 'Roman' drains), noisy or repeating dipolar anomalies from terracotta pipes or reduced magnetic field strength anomalies from culverts, plastic or non-reinforced concrete pipes. In all cases identification of a herring bone pattern to these is sufficient for inclusion within this category.

4.4.4 Features of archaeological interest

Any linear or discrete enhancement of magnetic field strength, usually with a dipolar character of variable strength, that cannot be categorised as a field boundary, cultivation or as having a geological origin, is classified as a fill potentially being of archaeological interest. Fills are normally earthen and include an often invisible proportion of heated soil or topsoil that augments local magnetic field strength. Inverted anomalies are possible over non-earthen fills, e.g. those that comprise peat, sand or gravel within soil. This category is subject to the 'habitation effect' where, in the absence of other sources of magnetic material, anomaly strength will decrease away from sources of heated soil and sometimes to the extent of non-detectability.

Former enclosure ditches that contained standing water can promote enhanced volumetric magnetic susceptibility through depositional remanence and remain detectable regardless of the absence of other sources of magnetic enhancement.

Anything that cannot be interpreted as a fill tends to be a structure, or in archaeological terms, a feature. This category is secondary to fills and includes anomalies that by virtue of their character are likely to be of archaeological interest but cannot be adequately described as fills. Examples include strongly magnetic bodies lacking ferrous character that might indicate hearths or kilns. In some cases anomalies of ferrous character may be included.

On some sites the combination of plan form and anomaly character, e.g. rectilinear reduced magnetic field strength anomalies, might indicate the likely presence of masonry, robber trenches or rubble foundations. Other types of structure are only included if the evidence is unequivocal, e.g. small ring ditches with doorways and hearths. In some circumstances a less definite category may be assigned to the individual anomalies instead.

It is sometimes possible to define different areas of activity on the basis of magnetic character, e.g. texture and anomaly strength. These might indicate the presence of middens or foci within larger complexes. This category does not indicate a presence or absence of discrete anomalies of archaeological interest.

4.5 Glossary

Acronym / term	**Type**	**Definition**
A	Physical quantity	SI unit Amp of electric current
BGS	Organisation	British Geological Survey
CIfA	Organisation	Chartered Institute for Archaeologists
dB	Physical quantity	Decibel, unit of amplification / attenuation
DRM	Process	Depositional Remanent Magnetisation
EAGE	Organisation	European Association of Geoscientists and Engineers
EGNOS	Technology	European Geostationary Navigation Overlay Service
ERT	Technology	Electrical resistivity tomography
ETRS89	Technology	European Terrestrial Reference System (defined 1989)
ETSI	Organisation	European Telecommunications Standards Institute
EuroGPR	Organisation	European Ground Penetrating Radar Association, the trade body for GPR professionals
G-BASE	Data	British Geological Survey Geochemical Atlas
GeolSoc	Organisation	Geological Society of London, the chartered body for the geological profession
GNSS	Technology	Global Navigation Satellite System
GPR	Technology	Ground penetrating radar
GPS	Technology	Global Positioning System (US)
inversion	process	A combination of forward and backward modelling intended to construct a 2D or 3D model of the physical distribution of a variable from data measured on a 1D or 2D surface. It is fundamental to ERT survey
IP	Physical quantity	Induced polarisation (or chargeability) units mV/V or ms
m	Physical quantity	SI unit metres of distance
mbgl	Physical quantity	Metres below ground level
MHz	Physical quantity	SI unit mega-Hertz of frequency
MS	Physical quantity	Magnetic susceptibility, unitless
mS	Physical quantity	SI unit milli-Siemens of electrical conductivity

Acronym / term	Type	Definition
nT	Physical quantity	SI unit nano-Tesla of magnetic flux density
OFCOM	Organisation	The Office of Communications, the UK radio spectrum regulator
Ohm	Physical quantity	SI unit Ohm of electrical resistance
OS	Organisation	Ordnance Survey of Great Britain
OSGB36	Data	The OS national grid (Great Britain)
OSTN15	Technology	Current coordinate transformation from ETRS89 to OSGB36 co-ordinates
RDP	Physical quantity	Relative Dielectric Permittivity, unitless
RTK	Technology	Real Time Kinematic (correction of GNSS position from a base station)
s	Physical quantity	SI unit seconds of time
TMI	Physical quantity	Total magnetic intensity (measured flux density minus regional flux density)
TRM	Process	Thermo-Remanent Magnetisation
V	Physical quantity	SI unit Volt of electric potential
WGS84	Data	World Geodetic System (defined 1984)

4.6 Selected reference

Aspinall, A, *et al*, 2008, "Magnetometry for Archaeologists", Geophysical Methods for Archaeology, Altamira Press

Blakely, R J, 1996, "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press

CgMs, 2017, "Archaeological Desk-Based Assessment: Land at Aldham Mill Hill, Hadleigh, Suffolk" Unpublished Draft Report ref. MP/23877

Chartered Institute for Archaeologists, 2014 (Updated 2016), "Standard and guidance for archaeological geophysical survey", Reading

David, A, *et al*, 2008, "Geophysical Survey in Archaeological Field Evaluation", English Heritage

Gaffney, C, *et al*, 2002, "Technical Note 6: The use of geophysical techniques in archaeological evaluations", Institute for Archaeologists

Historic England, 2015, "Management of Research Projects in the Historic Environment", Swindon

Milsom, J, 2003, "Field Geophysics", 3rd edition, The Geological Field Guide Series, Wiley

Rawlins, B G *et al*, 2012, "The advanced soil geochemical atlas of England and Wales". British Geological Survey, Keyworth

Schmidt, A, 2013, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS

Scollar, I, 1990, "Archaeological Prospecting and Remote Sensing", Topics in Remote Sensing 2, Cambridge University Press

Tarling, D H, *et al* (ed.), 1999, "Palaeomagnetism and Diagenesis in Sediments", Geological Society, London, Special Publications, 151

Telford, W M, *et al*, 1990, "Applied Geophysics", 2nd Edition, Cambridge University Press

Suffolk County Council, 2017, "Requirements for Geophysical Survey", Bury St Edmunds

TigerGeo, 2017, "Land at Aldham Mill Hill, Hadleigh, Suffolk : Specification for Geophysical Survey" Unpublished WSI ref AMH171

4.7 Archiving and dissemination

An archive is maintained for all projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by TigerGeo on all material it has produced, the client having full licence to use such material as benefits their project. Where required, digital data and a copy of the report can be archived in a suitable repository, e.g. the Archaeology Data Service, in addition to our own archive.

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.

The client will determine the distribution path for reporting, including to the end client, other contractors, local authority etc., and will determine the timetable for upload of the project report to the OASIS Grey Literature library or supply of report or data to other archiving services, taking into account end client confidentiality.

TigerGeo reserves the right to display data rendered anonymous and un-locatable on its website and in other marketing or research publications.

5 Supporting information

5.1 Standards and quality (archaeology)

TigerGeo is developing an Integrated Management System (IMS) towards ISO certification for ISO9001, ISO14001 and OHSAS18001/ISO45001 and has appointed Alan Ward of Bigfoot Services Limited as our ISO/HSE Technical Advisor. For work within the archaeological sector TigerGeo has been awarded CIfA (Chartered Institute for Archaeologists) Registered Organisation status.

A high standard of client-centred professionalism is maintained in accordance with the requirements of relevant professional bodies including the Geological Society of London (GeolSoc) and the Chartered Institute for Archaeologists (CIfA). Senior members of TigerGeo are professional members of the GeolSoc (FGS), CIfA (MCIfA & ACIfA grades) and other appropriate bodies, including the European Association of Geoscientists and Engineers (EAGE) Near Surface Division (MEAGE) and the Institute of Professional Soil Scientists (MISoilSci).

In addition TigerGeo is a member of EuroGPR and all ground penetrating and other radar work is in accordance with ETSI EG 202 730.

The management team at TigerGeo have over 30 years of combined experience of near surface geophysical project design, survey, interpretation and reporting, based across a wide range of shallow geological contexts. Added to this is the considerable experience of our lead geophysicists in a variety of commercial and academic roles. All geophysical staff have graduate and in many cases also post-graduate relevant qualifications pertaining to environmental geophysics from recognised centres of academic excellence.

During fieldwork there is always a fully qualified (to graduate or post-graduate level) supervisory geophysicist leading a team of other geophysicists and geophysical technicians, all of whom are trained and competent with the equipment they are working with. Data processing and interpretation is carried out by a suitably qualified and experienced geophysicist under the direct supervision and guidance of the Senior Geophysicist. All work is monitored and reviewed throughout by the Senior Geophysicist who will appraise all stages of a project as it progresses.

Data processing and interpretation adheres to the scientific principles of objectiveness and logical consistency. A standard set of approved external sources of information, e.g. from the British Geological Survey, the Ordnance Survey and similar sources of data, in addition to previous TigerGeo projects, guide the interpretive process. Due attention is paid to the technical constraints of method, resolution, contrast and other geophysical factors.

There is a strong culture of internal peer-review within TigerGeo, for example, all reports pass through a process of authorship, technical review and finally proof-reading before release to the client. Technical queries resulting from TigerGeo's work are reviewed by the Senior Geophysicist to ensure uniformity of response prior to implementing any edits, etc.

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.

All work for archaeological projects is also 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 Geophysical survey", Chartered Institute for Archaeologists, 2014 (Updated 2016);

and TigerGeo 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".

5.2 Key personnel

Senior Geophysicist (Quality manager)	Martin Roseveare MSc BSc(Hons) MEAGE FGS MCIfA
Martin specialised (MSc) in geophysical prospection for shallow applications and since 1997 has worked in commercial geophysics. Elected a GeolSoc Fellow in 2009 he is now working towards achieving CSci. A member of the European Association of Geoscientists & Engineers, he has served on the EuroGPR and CIfA GeoSIG committees and on the scientific committees of the 10th and 11th Archaeological Prospection conferences. He has reviewed papers for the EAGE Near Surface conference, was a technical reviewer of the Irish NRA geophysical guidance and is a founding member of the ISSGAP soils group. Professional interests include the application of geophysics to agriculture and the environment, e.g. groundwater and geohazards. He is also a software writer and equipment integrator with significant experience of embedded systems.	
Operations Manager (Safety manager)	Anne Roseveare BEng(Hons) DIS MISoilSci
On looking beyond engineering, Anne turned her attention to environmental monitoring and geophysics. She is a Member of the British Society of Soil Science (BSSS) and has specific areas of interest in soil physics & hydrology, agricultural applications and industrial sites. Amongst other contributions to the archaeological geophysics sector over the last 18 years, Anne was the founding Editor of the International Society for Archaeological Prospection (ISAP) and is a founding member of the ISSGAP soils group. Specifications, logistics, safety, data handling & analysis are integral parts of her work, though she is happily distracted by the possibilities of discovering lost cities, hillwalking and good food.	
Archaeological Consultant	Daniel Lewis MA BA(Hons) ACIfA
Daniel studied archaeology at the University of Nottingham and worked in field archaeology for many years, managing urban and rural fieldwork projects in and around Herefordshire. When the desk became more appealing he jumped into the world of consulting, working on small and large multi-discipline projects throughout England and Wales. At the same time, he returned to University, gaining an MA in Historic Environment Conservation. With over 15 years' experience in the heritage sector, Daniel has a diverse portfolio of skills. Here he ensures that geophysical work within the heritage sector is well grounded in the archaeology. His spare time includes much running up mountains.	
Environmental Geophysicist	Kathryn Cunningham BSc(Hons) FGS
Kathryn has been with TigerGeo since its inception and has undertaken over 100 surveys comprising total field magnetometry, twin probe resistivity, electrical resistance tomography, ground penetrating radar and laser-scanning. Her particular role is to ensure all aspects of fieldwork run smoothly, including site-specific paperwork, liaison, internal auditing and risk assessment. In addition she has increasing responsibilities in data processing and interpretation. She graduated with a BSc (Hons) in Applied Geology in 2015 from the University of Plymouth, is a Fellow of the Geological Society and enjoys acrobatics and sunny days.	
Environmental Geophysicist	Jack Wild BSc(Hons) FGS
Down to earth and a Plymouth University graduate in geology Jack entered the world of shallow geophysics with an Atkinson Leapfrog. Happiest when in the field he has undertaken geological projects Europe wide including in Sicily and the Spanish Pyrenees and closer to home has studied much of the Cornish and Devon coast. The mystery of what lies below drives his interest in the collection and interpretation of high quality data - be it from magnetometry or GPR he just cannot resist(ivity)! Jack is a Fellow of the Geological Society.	
Environmental Geophysicist	Jose Almendros BSc

Jose studied geology in University of Granada developing a special interest in geophysics. When he finished his studies he went to Chile, where he worked two years in a geophysical company undertaking projects for agriculture, mining, ground flows and utilities. Jose likes all stages related with geophysics, from data collection and processing to interpretation. When he is not working he likes to watch series and films, cycling and walking in stunning landscapes.

6 Appendices

6.1 Appendix 1 – OASIS Summary Form

OASIS DATA COLLECTION FORM: England

List of Projects | Manage Projects | Search Projects | New project | Change your details | HER coverage | Change country | Log out

Printable version

OASIS ID: tigergeo1-304047

Project details

Project name	Land at Aldham Mill Hill, Hadleigh, Suffolk
Short description of the project	A magnetic survey was commissioned by CgMs Limited (Part of the RPS Group) to prospect land at Aldham Mill Hill, Hadleigh, Suffolk, for buried structures of archaeological interest. Survey was undertaken using an ATV-towed and GNSS-tracked non-gradiometric array of caesium vapour magnetometers on a non-magnetic platform. Two clear and large likely Bronze Age funerary monuments with multiple encircling ditches and internal features are present in the southern part of the site and were expected from cropmark evidence and other examples found just beyond the survey. A third Bronze Age funerary monument, also expected from cropmark evidence, is less obvious and a smaller cropmark, to the north, has not been detected. North of these funerary monuments a large Roman era enclosure has been found and is likely to have included a contemporary farming settlement although this has not been seen in the data. There is possible, although ambiguous, evidence for Iron Age or later funerary activity, including a small square enclosure. A number of linear ditch fills and a possible track or similar structure might indicate the former presence of former field systems lost prior to the 1880s Ordnance Survey mapping.
Project dates	Start: 21-12-2017 End: 21-12-2017
Previous/future work	Not known / Not known
Any associated project reference codes	HER Parish No: HAD 160 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	BARROW Bronze Age
Significant Finds	NONE None
Methods & techniques	'''Geophysical Survey'''
Development type	Landowner pre-sale planning application (outline)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Newhaven Chalk Formation - Chalk

Drift geology	ALLUVIUM
Drift geology (other)	River Terrace Deposits, 2 - Sand And Gravel
Techniques	Magnetometry

Project location

Country	England
Site location	SUFFOLK BABERGH HADLEIGH Land at Aldham Mill Hill, Hadleigh, Suffolk
Postcode	IP7 6RF
Study area	9 Hectares
Site coordinates	TM 602460 243413 51.856172213845 1.779819212924 51 51 22 N 001 46 47 E Point

Project creators

Name of Organisation	TigerGeo Ltd
Project brief originator	Consultant
Project design originator	TigerGeo Ltd
Project director/manager	MJ Roseveare
Project supervisor	J Wild
Type of sponsor/funding body	Developer

Project archives

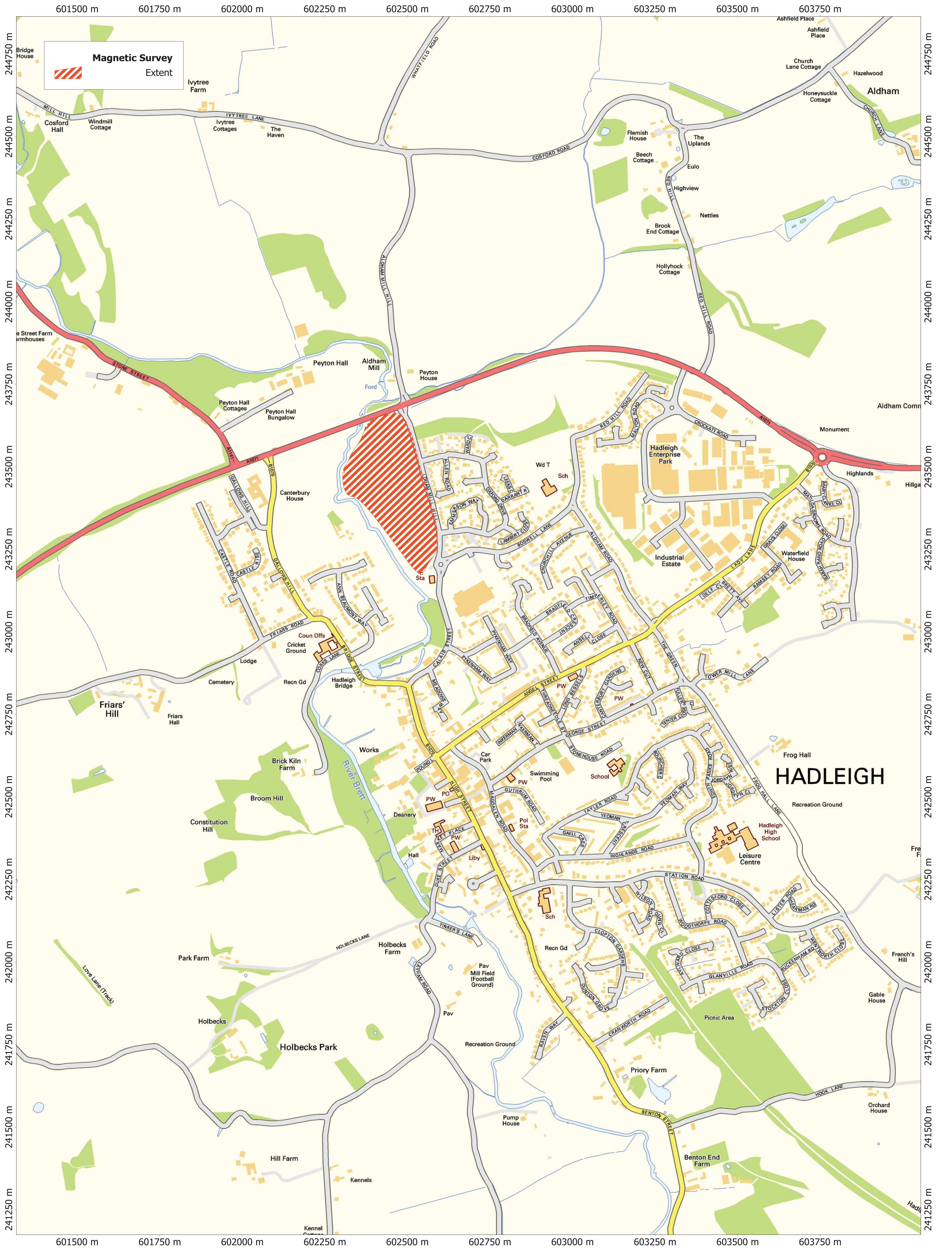
Physical Archive Exists?	No
Digital Archive recipient	TigerGeo Ltd
Digital Contents	"Survey"
Digital Media available	"GIS","Geophysics","Text"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Land at Aldham Mill Hill, Hadleigh, Suffolk
Author(s)/Editor(s)	Roseveare, MJ
Other bibliographic details	Version 1.1
Date	2018
Issuer or publisher	TigerGeo Ltd

Place of issue or publication	TigerGeo Ltd
Description	Text report with illustrations.
Entered by	Daniel Lewis (d.lewis@tigergeo.com)
Entered on	1 October 2018

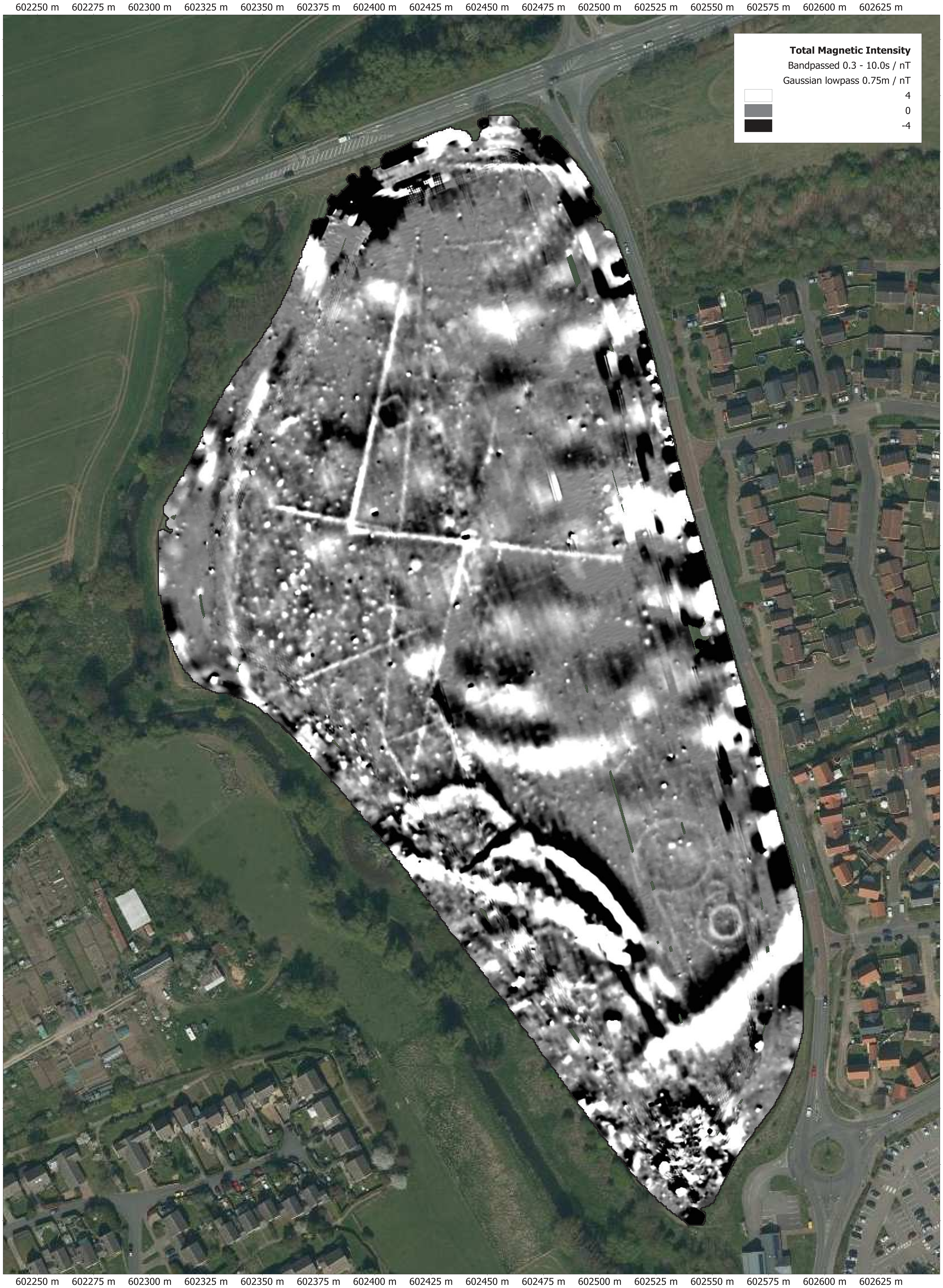
OASIS:



AMH171 Land at Aldham Mill Hill, Hadleigh, Suffolk
DWG 01 Site Location

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

TIGERGEO



AMH171 Land at Aldham Mill Hill, Hadleigh, Suffolk
DWG 02 Magnetic Data - Total Magnetic Intensity

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
File: AMH171.map

TIGERGEO

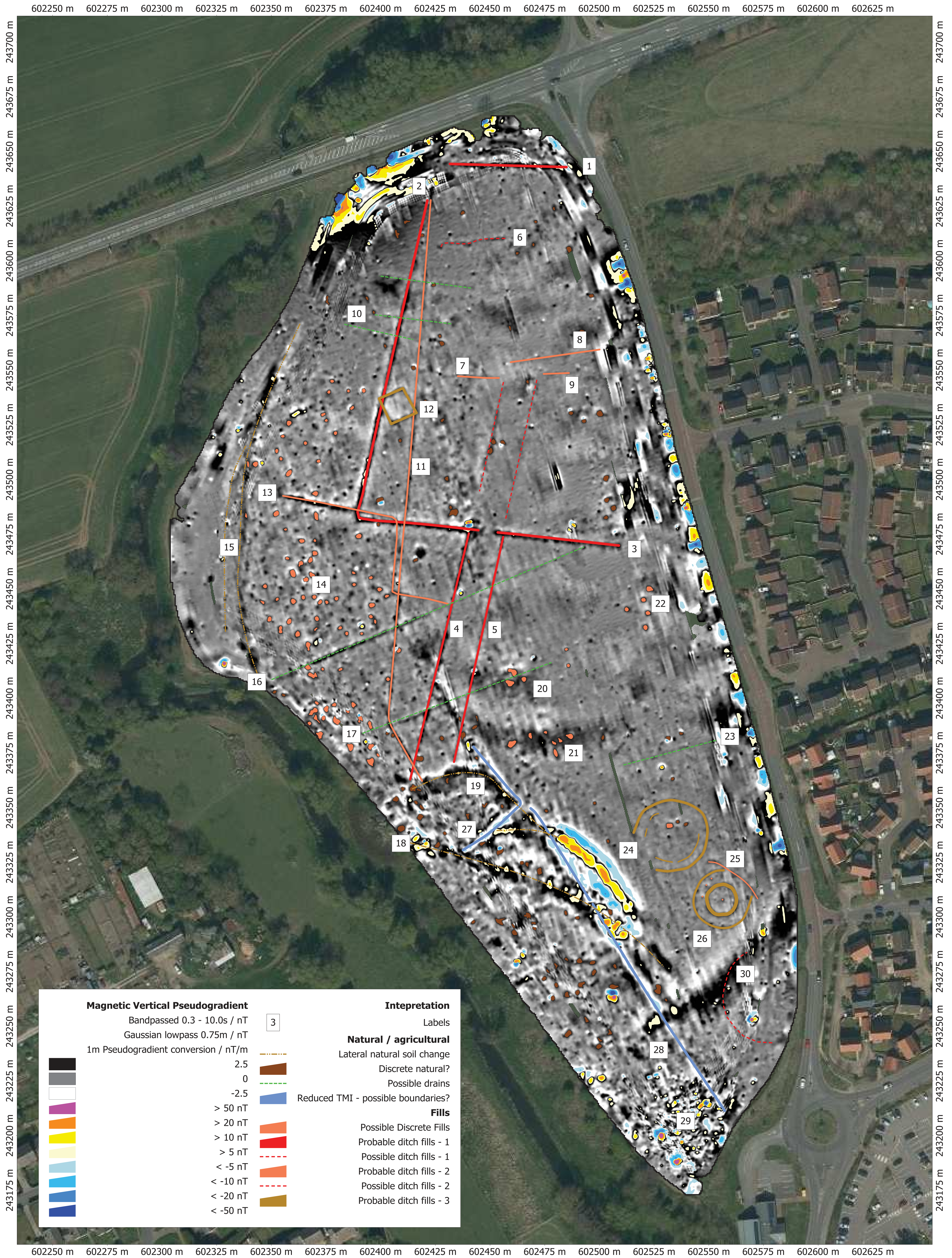
AMH171 Land at Aldham Mill Hill, Hadleigh, Suffolk

DWG 03 Magnetic Data - 1m Vertical Pseudogradient

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing

File: AMH171.map

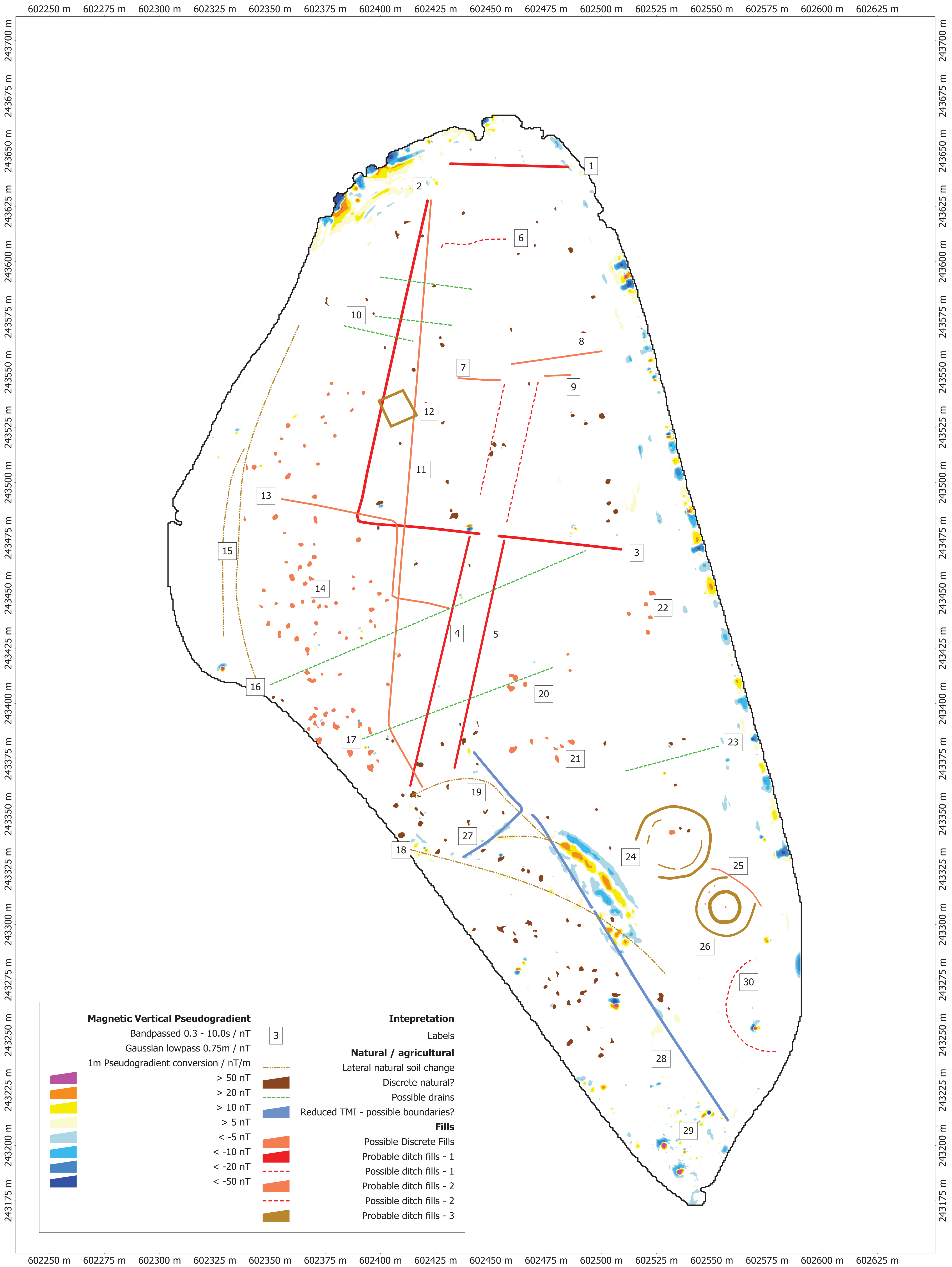
TIGERGEO



AMH171 Land at Aldham Mill Hill, Hadleigh, Suffolk
DWG 04 Interpretation

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
File: AMH171.map

TIGERGEO



AMH171 Land at Aldham Mill Hill, Hadleigh, Suffolk
DWG 05 Interpretation - Vector

Orthographic Scale: 1:1500 @ A3 Spatial Units: Meter. Do not scale off this drawing
File: AMH171.map

TIGERGEO