

Geophysical Survey Report

Whittington Way, Bishop's Stortford

for

CgMs Consulting Ltd

September 2007

J2380

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Client: CgMs Consulting Ltd

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Techniques: Detailed magnetic survey (gradiometry)

National Grid Ref: TL 485 190



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1 SUMMARY OF RESULTS

The geophysical survey undertaken over 20ha of agricultural land near Whittington Way, Bishop's Stortford has located a number of anomalies of an archaeological origin including a rectilinear enclosure, a circular ditch feature and a possible settlement site. Discrete positive anomalies suggesting the presence pits of a possible archaeological origin are evident across the survey area.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by CgMs Consulting Ltd to undertake a geophysical survey of an area outlined for development.

2.2 Site location

The site is located near Whittington Way, Bishop's Stortford at OS ref. TL 485 190.

2.3 Description of site

The survey area consists of 20ha of agricultural land currently used as arable. The site slopes gently to the south.

2.4 Geology and soils

The underlying geology includes Oldhaven, Blackheath, Woolwich & Reading and Thanet beds (British Geological Survey South Sheet, Fourth Edition Solid, 2001).

The overlying soils are known as Melford soils which are typical argillic brown earths. These consist of deep, well drained fine loamy over clayey, coarse loamy over clayey and fine loamy soils (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.5 Site history and archaeological potential

Paragraph 6.4 of CgMs' desk based assessment (Bourn, April 2007) states:

"In view of recent archaeological investigations within and in the vicinity of the site, a potential is identified for Late Bronze Age, Iron Age and Roman sub-surface features evidencing settlement in localised areas of the site."

This would suggest that there is potential for the location of anomalies of an archaeological origin within the gradiometer data collected on site.

2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order that they may be assessed prior to development.

2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

3 **METHODOLOGY**

3.1 Date of fieldwork

The fieldwork was carried out over ten days from 13th August 2007. Weather conditions during the survey were varied.

3.2 Grid locations

The location of the survey grids is based on the Ordnance Survey National Grid, see Figure 2. The referencing and alignment of grids was achieved using a Leica DGPS System 500.

A DGPS (differential Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. Calculations to correct for these errors are performed at an accurately located base station. The base station then transmits the corrections which are received by DGPS consoles giving sub metre accuracy averaging around 0.5m error.

3.3 Survey equipment

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements increasing the sensitivity to small changes in the Earth's magnetic field.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

3.4.2 Depth of scan and resolution

The Grad601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution. The data is collected at a reading resolution of 0.1nT.

3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily downloaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3*. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters:

X radius = 1, y radius = 1, threshold = 3 std. dev.

Spike replacement = mean

2. *Zero mean grid* (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

Geoplot parameters:

Threshold = 0.25 std. dev.

3. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters:

Least mean square fit = off

3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figure 02) and trace plots (Figures 03 and 04), together with a greyscale plot of the processed data (Figure 05). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 06).

4 RESULTS

The gradiometer survey undertaken over 20ha of land off Whittington Way, Bishop's Stortford has identified a number of anomalies of archaeological origin.

In the western half of the survey area a number of positive and negative anomalies come together to form a complex feature that may be related to a prehistoric or Romano-British settlement site. A large rectilinear enclosure comprising of banks and ditches can be noted some 150m to the north east of this feature. Further investigation would be required in order to ascertain as to whether these features are contemporary however the long linear anomaly that seems to join the two together may suggest that this is the case.

A large positive circular anomaly is evident in the eastern half of the survey area. A number of other positive linear anomalies are evident within the survey area including two parallel anomalies in the south eastern limits.

Negative linear and area anomalies indicate the presence of former earthworks or banks of a possible archaeological origin. A number of these anomalies occur in close proximity to positive anomalies which may indicate some form of bank and ditch arrangement. This arrangement can be seen in the enclosure, the settlement and in the north western and south eastern limits of the survey area.

Discrete positive anomalies are evident throughout the survey area. These anomalies have been interpreted as pits of a possible archaeological origin.

Magnetic disturbance is evident within the survey area. The disturbance in the northern limits of the site is likely to be related to the construction of the road. A modern pipe or

cable located in the eastern half of the survey area has associated magnetic disturbance which may mask any subtle features of archaeological origin that may be located in its proximity.

Areas of magnetic variation and weak positive anomalies have been interpreted as being of a possible geological origin.

5 CONCLUSION

The geophysical survey undertaken at Whittington Way, Bishop's Stortford has identified a number of anomalies of archaeological origin. A complex of ditches and banks in the western half of the survey area may represent a Romano-British settlement site. A rectilinear enclosure can be noted in the northern region of the site and a circular anomaly is evident in the eastern half of the survey area. Further investigation would be necessary in order to ascertain as to how these features relate to one another.

6 REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern England*.

APPENDIX A – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

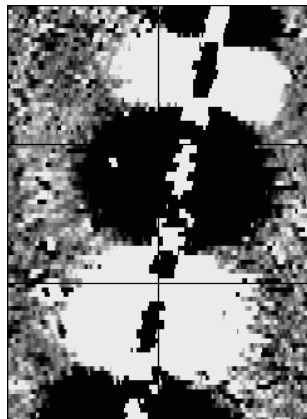
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

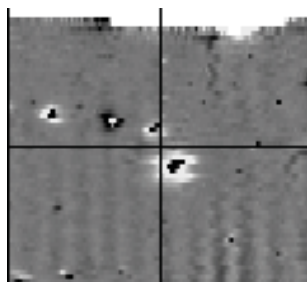
APPENDIX B – Glossary of magnetic anomalies

Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

Dipolar

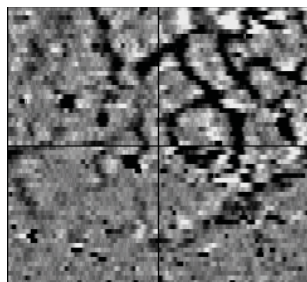


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

Positive anomaly with associated negative response

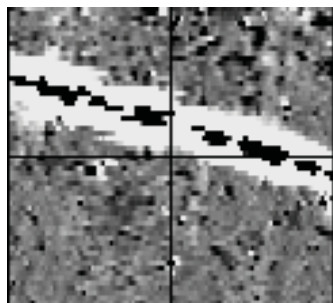
See bipolar and dipolar.

Positive linear



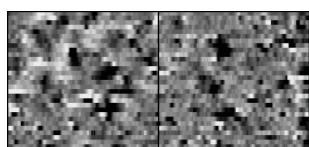
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

Positive linear anomaly with associated negative response



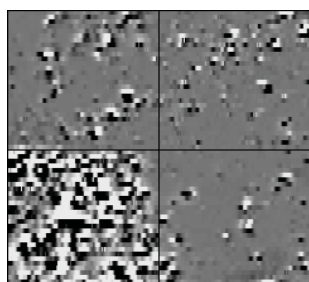
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

Positive point/area



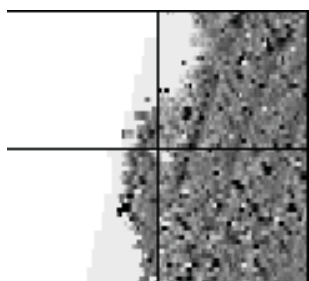
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

Magnetic debris



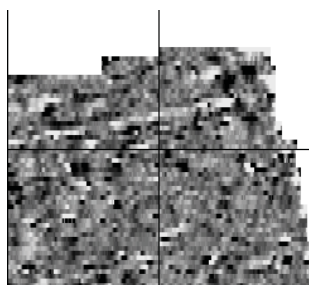
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low ($\pm 3nT$) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly ($\pm 250nT$) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent remnant material such as bricks or ash.

Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

Negative linear

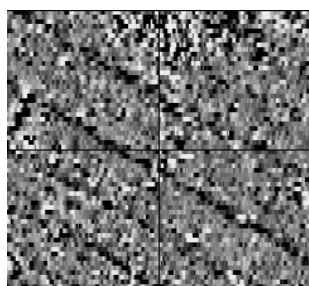


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

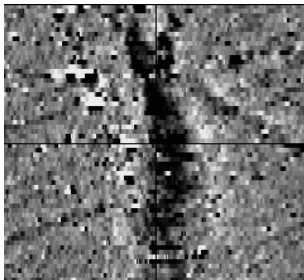
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a 10m² area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Trace plots are used to show the amplitude of response.

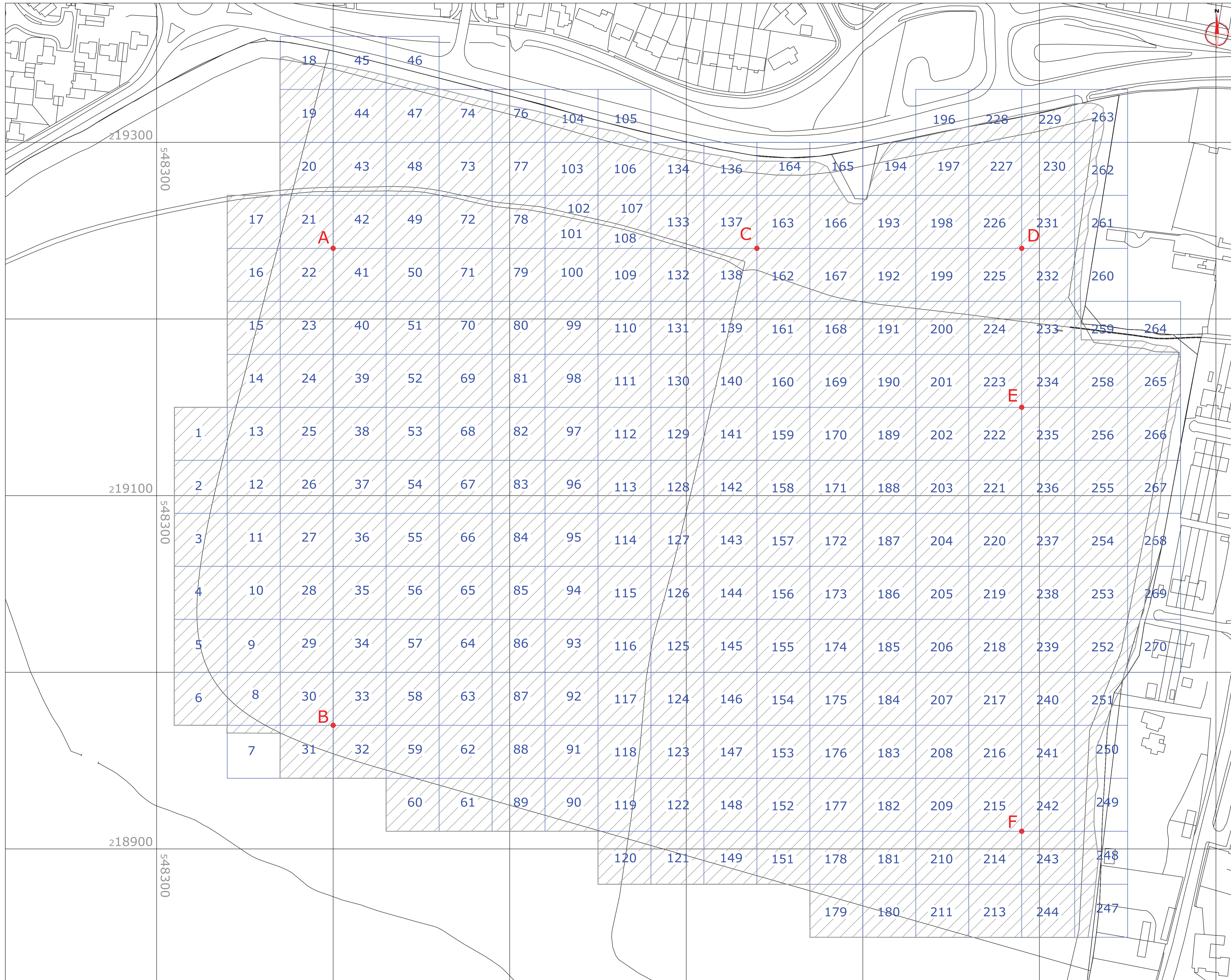
Thermoremnant response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred insitu (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

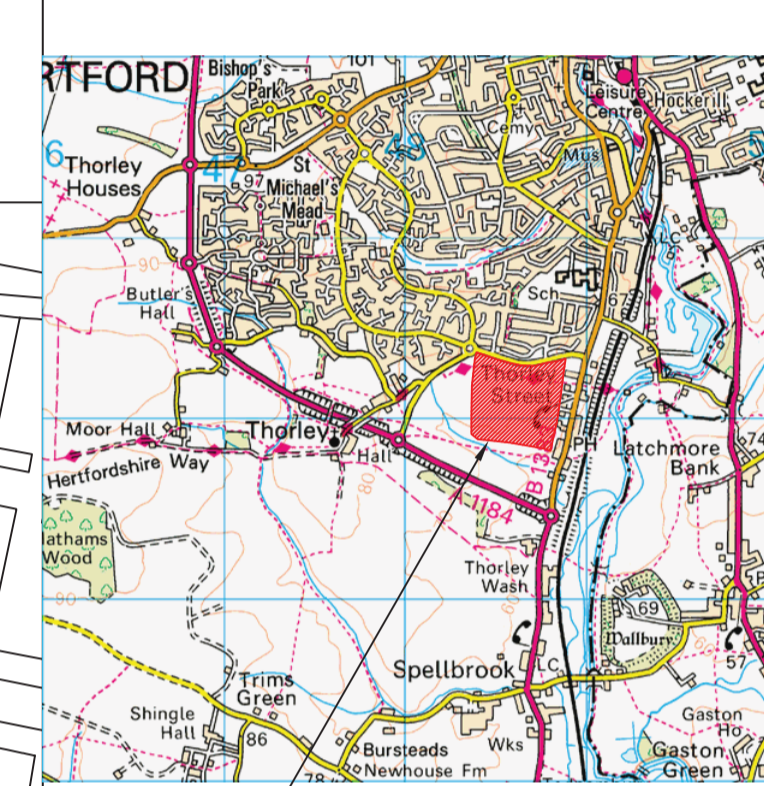


Amendments

Issue No.	Date	Description
-	-	-
-	-	-

Site centred on NGR TL 485 190

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office. Crown Copyright reserved. Licence No: AL 50125A
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 Upton Upon Severn
 WR8 0SA
 OS 100km square = TL



OS GRID REFERENCES

A	548400 , 219240
B	548400 , 218970
C	548640 , 219240
D	548790 , 219240
E	548790 , 219150
F	548790 , 218910
33	Grid number
Area surveyed within grid	
Job No.	2380
Survey Date	AUG 2007

Client
CgMs CONSULTING LTD

Project Title
**GEOPHYSICAL SURVEY-
 WHITTINGTON WAY,
 BISHOPS STORTFORD**

Subject

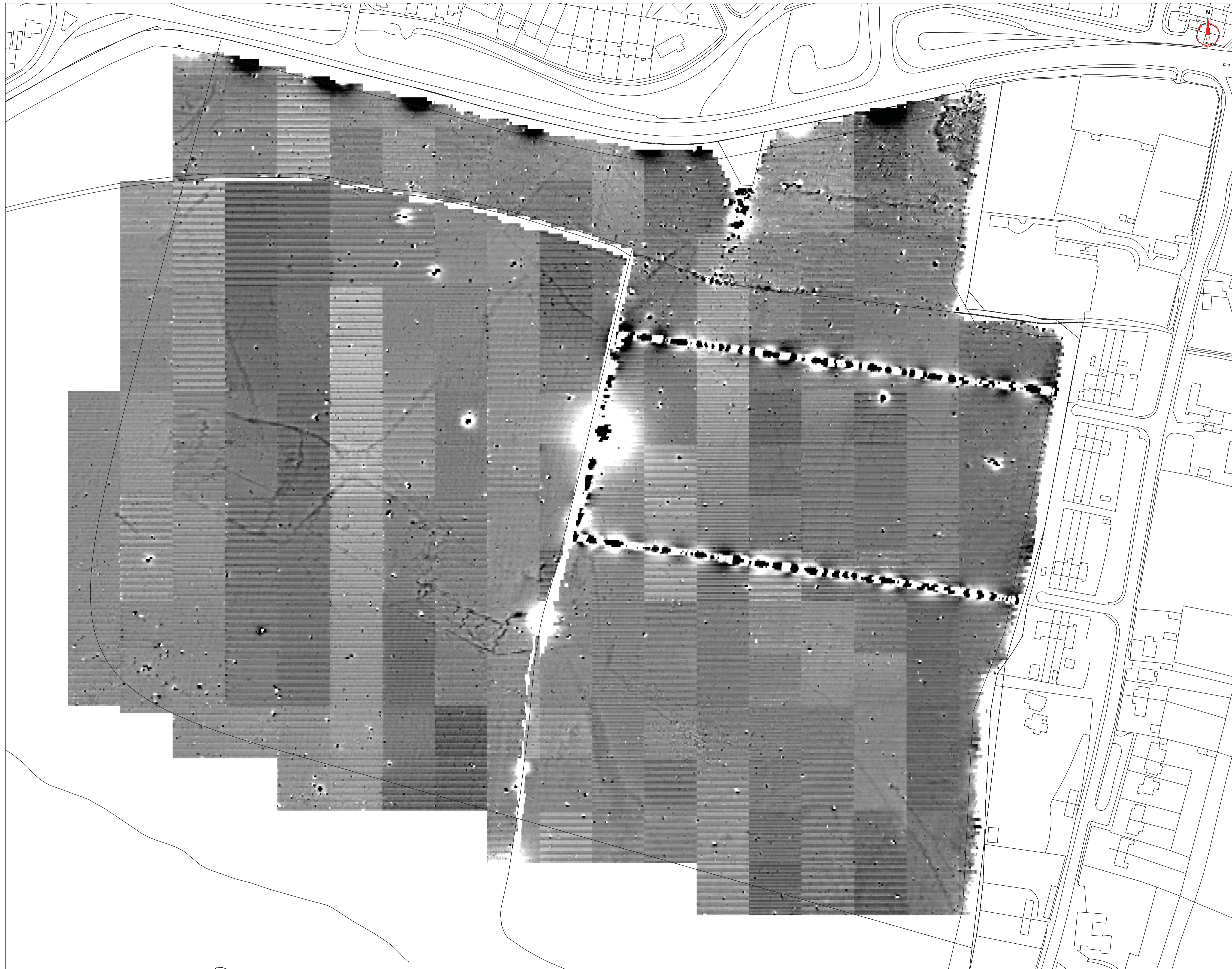
SITE LOCATION AND SURVEY AREA

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Scale
1:1000
 0m 10 20 30 40 50 60m

Plot	A1	Checked by	SAS	Issue No.	01
Date	SEPT 07	Drawn by	RAJS	Figure No.	01



Amendments		
Issue No.	Date	Description

Plotting parameters

Maximum +5nT (black)
Minimum -5nT (white)

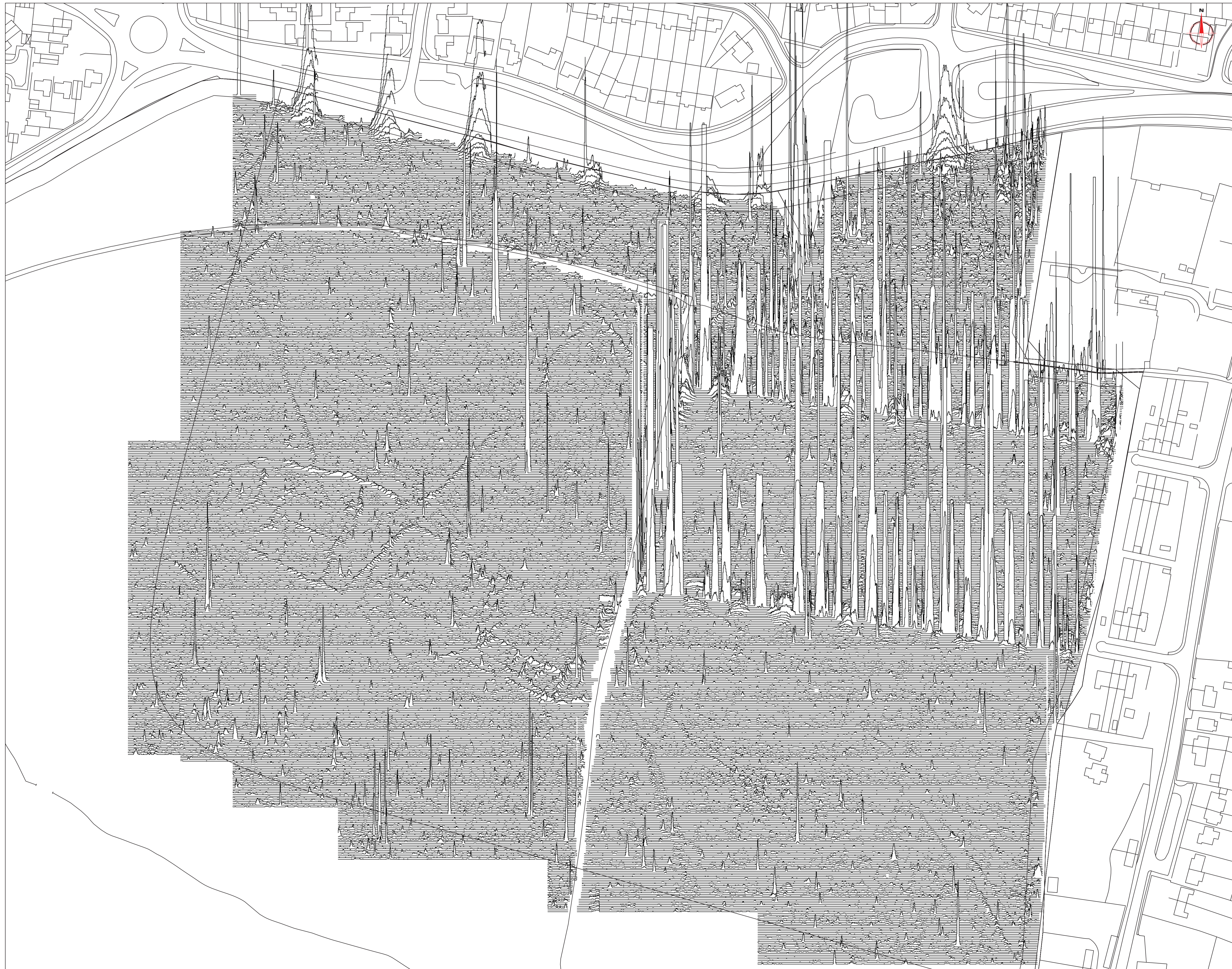
-3SD +3SD -5nT +5nT

Job No.	2380	Survey Date	AUG 2007
Client	CgMs CONSULTING LTD		
Project Title	GEOPHYSICAL SURVEY- WHITTINGTON WAY, BISHOPS STORTFORD		
Subject	PLOT OF RAW GRADIOMETER DATA		

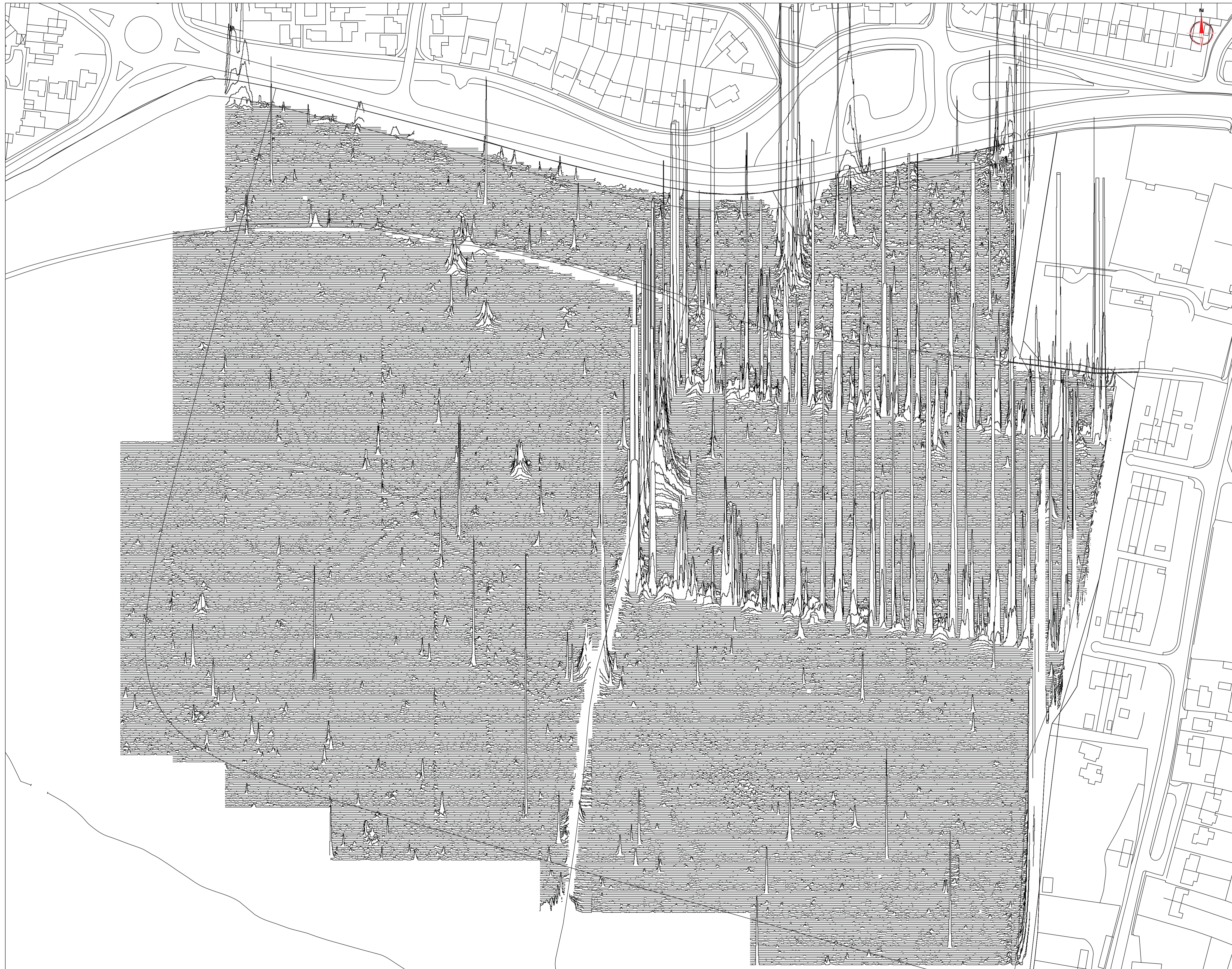
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Scale 1:1000
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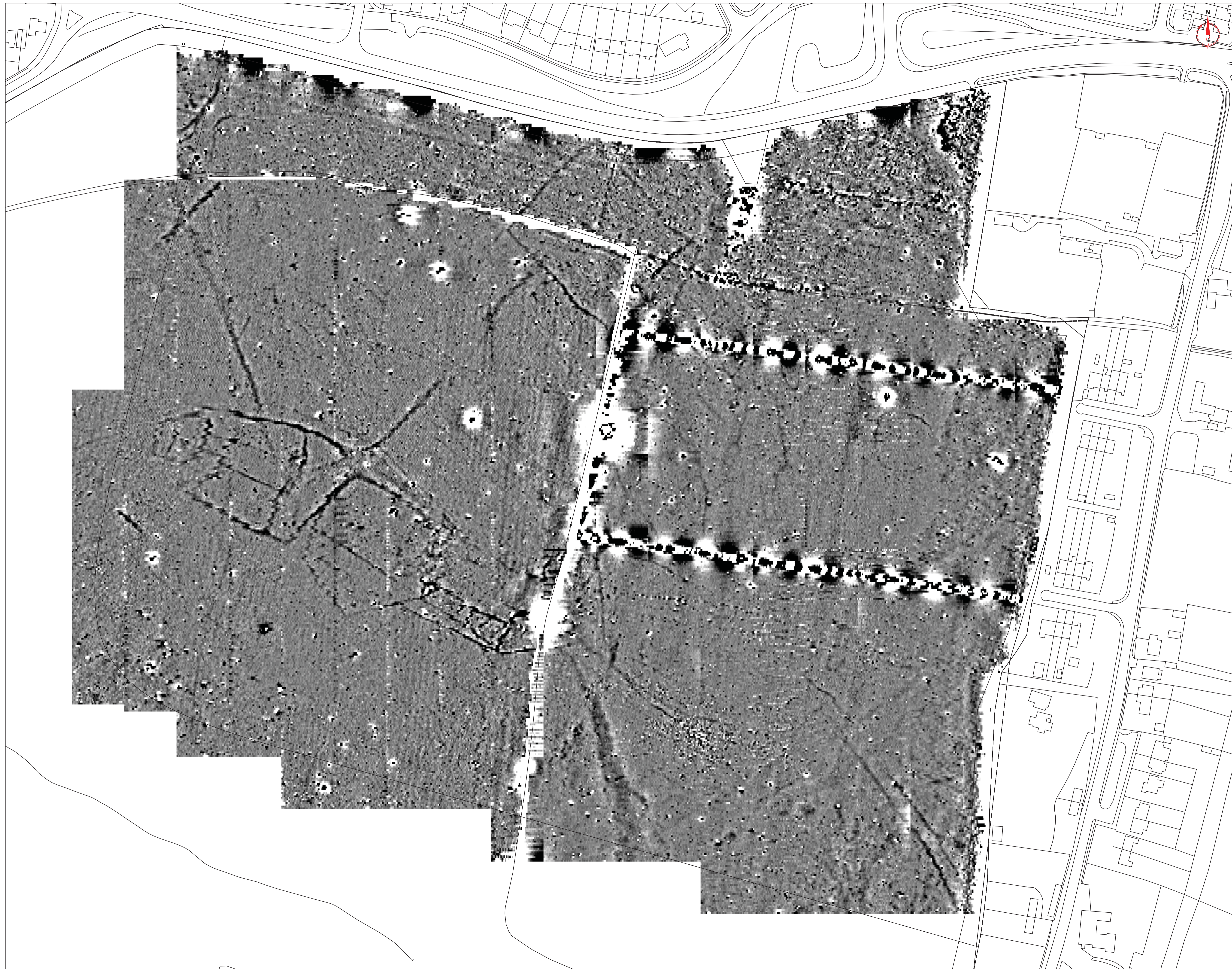
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A1	SAS	01
Date	Drawn by	Figure No.
SEPT 07	RAJS	02



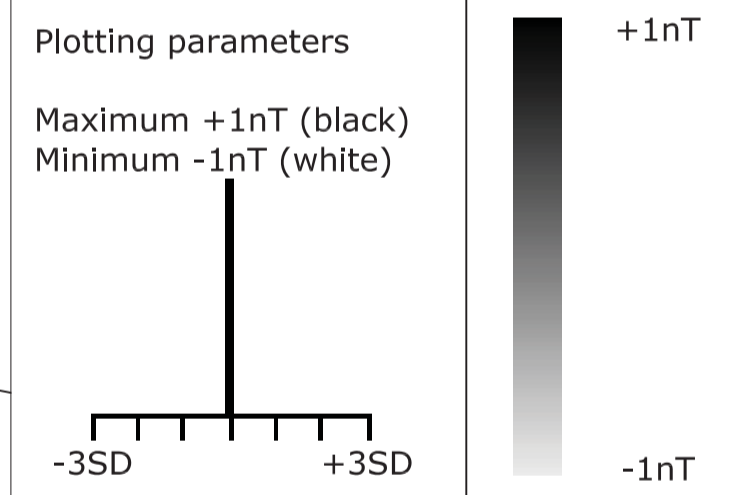
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<p>200nT</p> <p>160nT</p> <p>120nT</p> <p>80nT</p> <p>40nT</p> <p>0nT</p>		
Job No.	2380	Survey Date AUG 07
Client	CgMs CONSULTING LTD	
Project Title	GEOPHYSICAL SURVEY- WHITTINGTON WAY, BISHOPS STORTFORD	
Subject	TRACE PLOT SHOWING POSITIVE VALUES	
<p>STRATASCAN™ GEOPHYSICS FOR ARCHAEOLOGY AND ENGINEERING VINEYARD HOUSE UPPER HOOK ROAD UPTON UPON SEVERN UK WR8 0SA T: +44 (0)1684 592266 F: +44 (0)1684 594142 E: info@stratascan.co.uk www.stratascan.co.uk</p>		
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1:1000		
Plot	Checked by PPB	Issue No. 01
Date SEPT 07	Drawn by RAJS	Figure No. 03



Amendments		
Issue No.	Date	Description
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<i>(Positive values displace above the trace line. Hidden values have not been plotted)</i>		
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Job No.	2380	Survey Date AUG 07
Client	CgMs CONSULTING LTD	
Project Title	GEOPHYSICAL SURVEY- WHITTINGTON WAY, BISHOPS STORTFORD	
Subject	TRACE PLOT SHOWING NEGATIVE VALUES	
<p>STRATASCAN™ GEOPHYSICS FOR ARCHAEOLOGY AND ENGINEERING VINEYARD HOUSE UPPER HOOK ROAD UPTON UPON SEVERN UK</p> <p>WR8 0SA T: +44 (0)1684 592266 F: +44 (0)1684 594142 E: info@stratascan.co.uk www.stratascan.co.uk</p>		
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Date SEPT 07	Drawn by RAJS	Figure No. 04



Amendments		
Issue No.	Date	Description
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Job No. 2380 Survey Date AUG 2007

Client
CgMs CONSULTING

Project Title
GEOPHYSICAL SURVEY-
WHITTINGTON WAY, BISHOPS
STORTFORD

Subject
PLOT OF PROCESSED
GRADIOMETER DATA

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Scale 1:1000
0m 10 20 30 40 50 60m

Plot	Checked by	Issue No.
A1	SDH	01
Date	Drawn by	Figure No.
SEPT 07	RAJS	05



Amendments		
Issue No.	Date	Description
KEY		
	Pipe or cable	
	Positive linear anomaly - probable agricultural mark	
	Positive linear anomaly - cut feature of possible archaeological origin	
	Negative linear anomaly - possible bank feature of archaeological origin	
	Weak bipolar anomaly - likely to be associated with field drains	
	Linear anomaly of uncertain origin	
	Bipolar linear anomaly - related to footpath	
	Linear anomaly of probable geological origin	
	Positive area anomaly - cut feature of possible archaeological origin	
	Negative area anomaly - possible former earthwork/bank	
	Discrete positive response - possible pit	
	Strong discrete positive response with associated negative response - likely ferrous object	
	Magnetic disturbance - related to nearby metallic object	
	Magnetic disturbance - evidence of ground disturbance or tipping	
	Magnetic variation - possibly related to spread of hardcore	
	Area of magnetic variation - possible geological / pedological response	
Job No.	2380	Survey Date
Client	AUG 2007	
CgMs CONSULTING		
Project Title		
WHITTINGTON WAY, BISHOPS STORTFORD		
Subject		
INTERPRETATION		
STRATASCAN™ GEOPHYSICS FOR ARCHAEOLOGY AND ENGINEERING VINEYARD HOUSE UPPER HOOK ROAD UPTON UPON SEVERN UK WR8 0SA T: +44 (0)1684 592266 F: +44 (0)1684 594142 E: info@stratascan.co.uk www.stratascan.co.uk		
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1:1000		
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A1	SDH	01
Date	Drawn by	Figure No.
SEPT 07	RAJS	06