STRATASCAN

Geophysical Survey Report

Creed Road, Oundle

for

Archaeological Solutions Ltd

October 2009

Job ref: J2651

Simon Stowe BSc (Hons) & Claire Graham BA (Hons)

Document Title:	**Geophysical Survey Report Creed Road, Oundle**
Client:	**Archaeological Solutions Ltd**
Stratascan Job No:	**J2651**
Techniques:	**Detailed magnetic survey (gradiometry)**
National Grid Ref:	**TL 030 890**

Plate 1: Looking North East across the survey area

Field Team:	**Simon Stowe BSc (Hons), Allen Wright BA (Hons) PIFA**
Project Manager:	**Simon Stowe BSc (Hons)**
Report written by:	**Simon Stowe BSc (Hons) & Claire Graham BA (Hons)**
CAD illustration by:	**Simon Haddrell BEng (Hons) AMBCS PIFA & Claire Graham BA (Hons)**
Checked by:	**Peter Barker C.Eng MICE MCIWEM MIFA**

Stratascan Ltd.

Vineyard House
Upper Hook Road
Upton upon Severn
WR8 0SA

Tel: 01684 592266
Fax: 01684 594142
Email: ppb@stratascan.co.uk

www.stratascan.co.uk

LIST OF FIGURES

1 SUMMARY OF RESULTS

The survey carried out at Creed Road, Oundle has identified several anomalies that are likely to be of archaeological origin, including an enclosure in the east of the survey area. A circular feature of some 10m diameter lies within the rectilinear enclosure which may be associated with a dwelling. Several other ditches that may have formed other enclosures are also seen. Further strong anomalies have been observed to the immediate north of the enclosure that are likely to be contemporaneous. Ridge and furrow ploughing activity dominates the magnetic data but weak evidence of archaeology can be seen in the form of positive linear and area anomalies which may relate to former ditches and pits.

2 INTRODUCTION

2.1 Background synopsis

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

2.2 Site location

The site is located to the west of Oundle at OS ref. TL 030 890.

2.3 Description of site

The survey area is approximately 4 hectares of arable land to the north west of Oundle, Northamptonshire. The site is bounded to the north and east by residential developments. The area has been recently deeply ploughed.

2.4 Geology and soils

The underlying geology is Great Oolite (British Geological Survey South Sheet, Fourth Edition Solid, 2001). There is no drift geology recorded at the site.

The overlying soils in the eastern section of the site are known as Denchworth which are typical pelo-stagnogley soils. These consist of slowly permeable seasonally waterlogged clayey soils with similar fine loamy over clayey soils. (Soil Survey of England and Wales, Sheet 3 Midland and Western England). The overlying soils in the western section of the site are known as Hanslope which are typical calcareous pelosols. These consist of slowly permeable calcareous clayey soils. (Soil Survey of England and Wales, Sheet 3 Midland and Western England).

2.5 Site history and archaeological potential

The site lies within a designated area of Archaeological Priority by Northamptonshire County Council. A probable prehistoric isolated inhumation burial was found in the field immediately east of the site. Ariel photography has also revealed a possible prehistoric field boundary and possible enclosures to the east of the site. Iron Age remains, a single small Roman settlement and an early to middle Saxon cemetery were excavated in this area in 2001. The archaeological desk based assessment states:

"There is a very high potential for archaeological remains dating to the Iron Age, Romano-British and Anglo-Saxon periods to be found within the site. Given that remains of each period have been found in conjunction to the field to the immediate east of the site, it is likely that such remains, if present, will be in higher quantity in the eastern section of the site" (Doyle 2007).

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 3 days from 5th to the 7th October 2009. Weather conditions during the survey were cloudy with scattered showers.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information. Grids were set out using a Leica Smart Rover RTK GPS.

An RTK GPS (Real-time Kinematic 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. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

3.3 Survey equipment

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

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 Grad 601 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 0.5m centres provides an optimum methodology for the task balancing cost and time with resolution.

3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily down-loaded 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 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 3) and a colour plot showing the extreme magnetic values (Figure 4), together with a greyscale plot of the processed data (Figures 5). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 6).

4 RESULTS

The data collected from Creed Road, Oundle is of good quality, despite data collection problems caused by the site being deep-ploughed at the time of survey. A variety of positive linear and area anomalies have been found throughout the site, the majority of

which are caused by ridge and furrow ploughing activity perpendicular to the current ploughing direction. A negative linear anomaly running parallel to the eastern edge of the survey area corresponds to a particularly deep furrow caused by the farmer ploughing the headlands. Magnetic disturbance is observed around the eastern and northern edge of the survey area, caused by metal fences and the housing development directly adjacent to the survey area. A large spread of magnetic debris seen across the eastern side of the dataset may also be related to this development. Other ferro-magnetic anomalies include a modern service running north to south through the western side of the survey area and various spikes probably caused by small near surface ferrous objects.

The strongest evidence for archaeological activity is seen in the east of the site, where strong positive linear anomalies with associated negative responses can be seen to form a rectilinear enclosure. The linear anomalies are not contiguous at the corners of the enclosure. Within the south of the enclosure several other positive linear anomalies can be seen at right angles with each other, which along with a small area of di-polar response seem to form a square. The di-polar response may be of modern rather than archaeological origin however, as it is very close to the site boundary and the associated magnetic disturbance. Inside the east of the enclosure several weaker positive linear anomalies can be seen, one of which forms a circle. The magnetic debris observed over this section of the site makes abstraction of these weaker anomalies difficult, and it is possible that any further low amplitude anomalies on the eastern extent of the site have been masked by the prevalence of magnetic disturbance.

Strong positive linear anomalies are also seen to the immediate north of the enclosure, although it is difficult to discern any structure associated with these anomalies due to the nearby magnetic disturbance. Two low amplitude positive linear anomalies are observed in the centre of the site, as well as further low amplitude positive linear anomalies in the western extents of the survey area. Several positive area anomalies are seen across the site which may relate to pits of an archaeological origin.

5 CONCLUSION

The gradiometer survey has highlighted several strong anomalies to the east of the site that seem to form an enclosure that appears to extend eastward out of the survey area and contains a small circular enclosure possibly associated with a dwelling. The linear anomalies forming the enclosure are not contiguous, which may indicate that the corners of the enclosure are open, or may have been ploughed out. Several linear anomalies within the enclosure to the south may have formed another enclosure. Further linear anomalies to the immediate north of the enclosure are also likely to be archaeologically significant. Unfortunately the high level of magnetic disturbance caused by the nearby housing makes it difficult to extract any further information from the data, and it is likely that further low amplitude anomalies associated with the enclosure have been masked as a result.

Elsewhere in the site evidence of archaeological activity is limited to pits and some weak ditch features, with agricultural activity dominating the magnetic data.

6 REFERENCES

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

Doyle, K. 2007. *Site at Creed Road, Oundle, Northamptonshire. An Archaeological desk-based assessment.* Archaeological Solutions Ltd.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 3 Midland and Western 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.

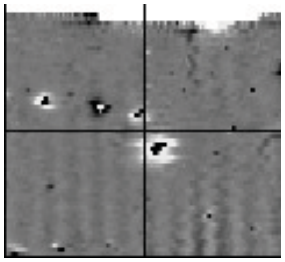
Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

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

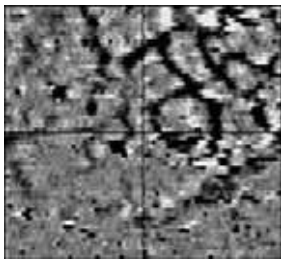


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

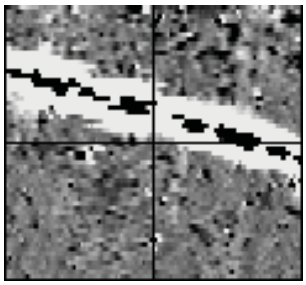
See bipolar and dipolar.

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

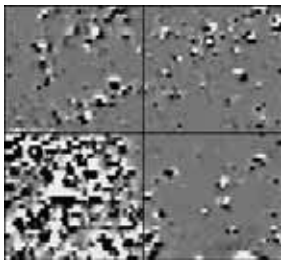


A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area

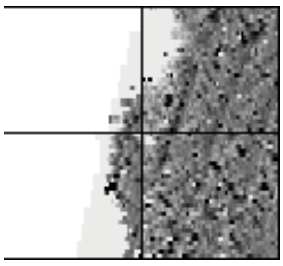
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



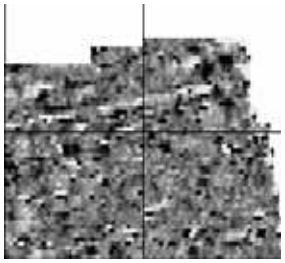
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

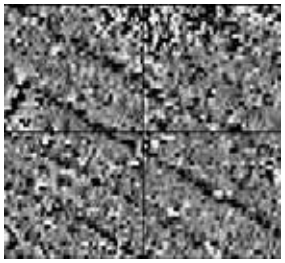


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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).

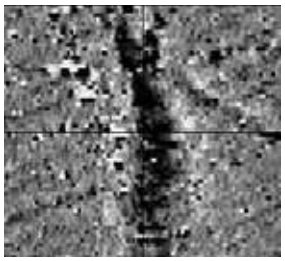
Strength of response

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 $10m^2$ 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.

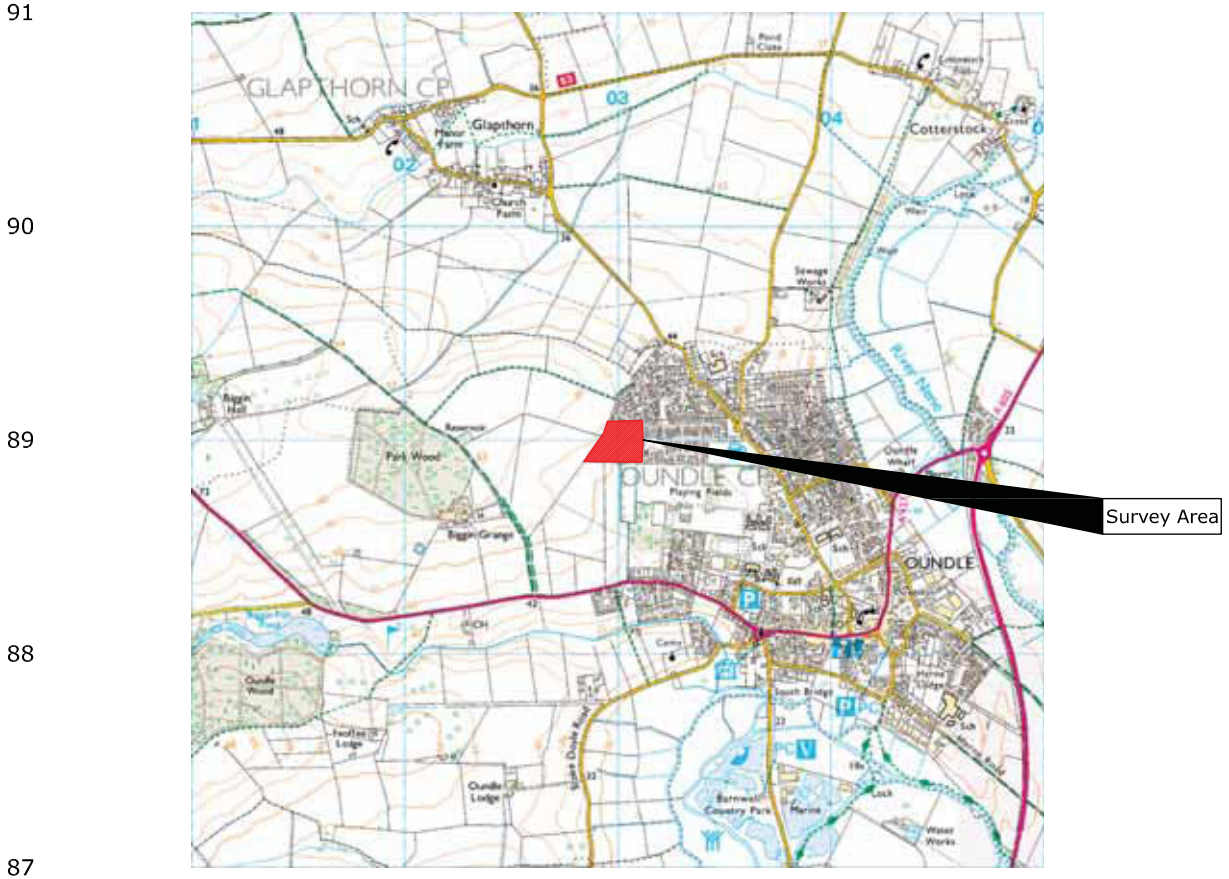
Thermoremnant response

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

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Site centred on NGR: TL 030 890

Client: ARCHAEOLOGICAL SOLUTIONS LTD

Project Title: GEOPHYSICAL SURVEY - CREED RD, OUNDLE

Job No. 2651

Subject: LOCATION PLAN OF SURVEY AREA

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

Scale: 1:25000 (0m, 500, 1000m)

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A3	PPB	01
Survey date	**Drawn by**	**Figure No.**
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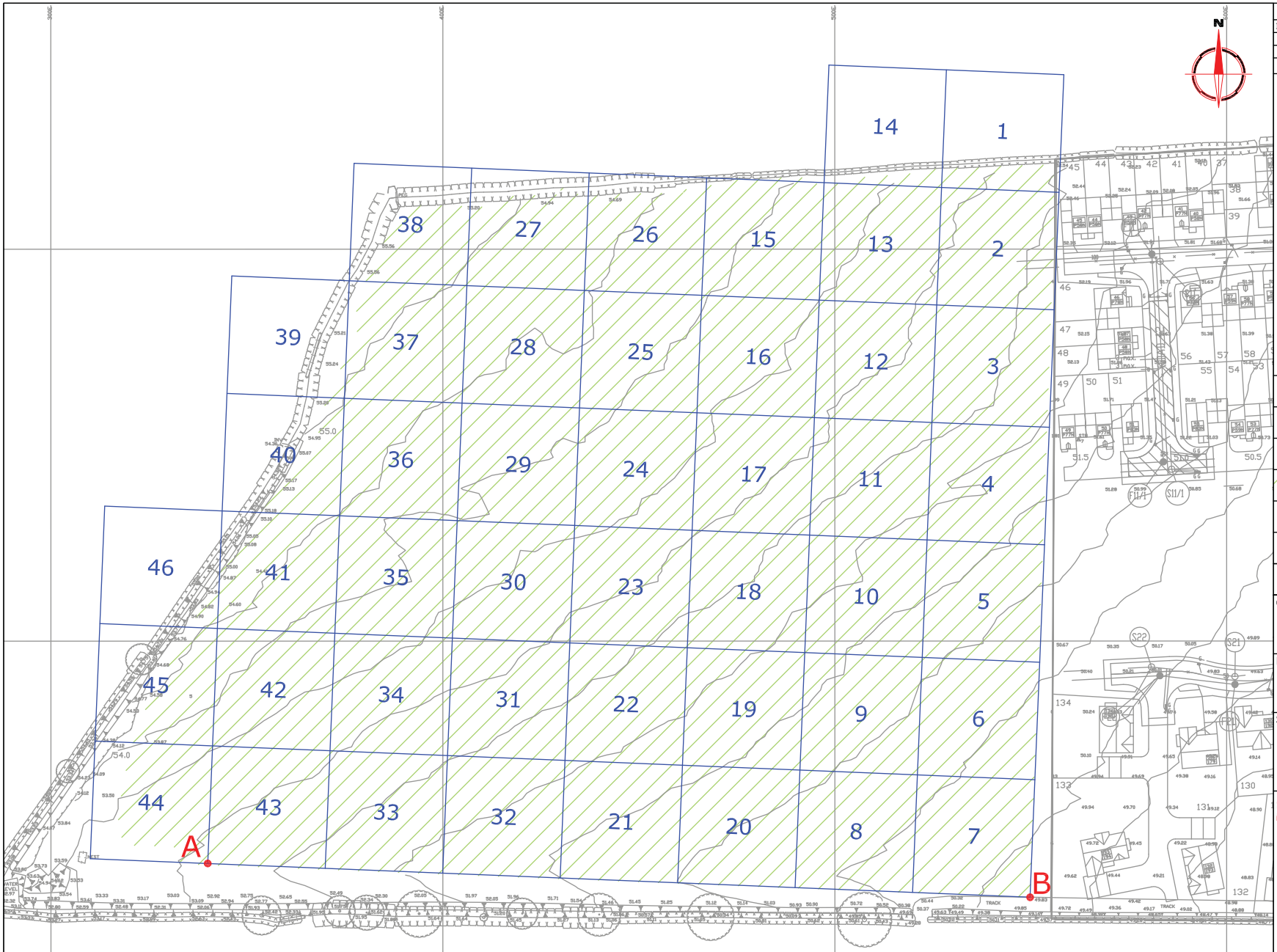

Amendments

Issue No.	Date	Description
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REFERENCING

A-B	BASELINE
2	GRID NUMBER
	SURVEY AREA

OS GRID REFERENCES

A	502909.74, 288908.75
B	503119.58, 288900.16

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GEOPHYSICAL SURVEY - CREED RD, OUNDLE

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LOCATION AND REFERENCING OF SURVEY GRIDS

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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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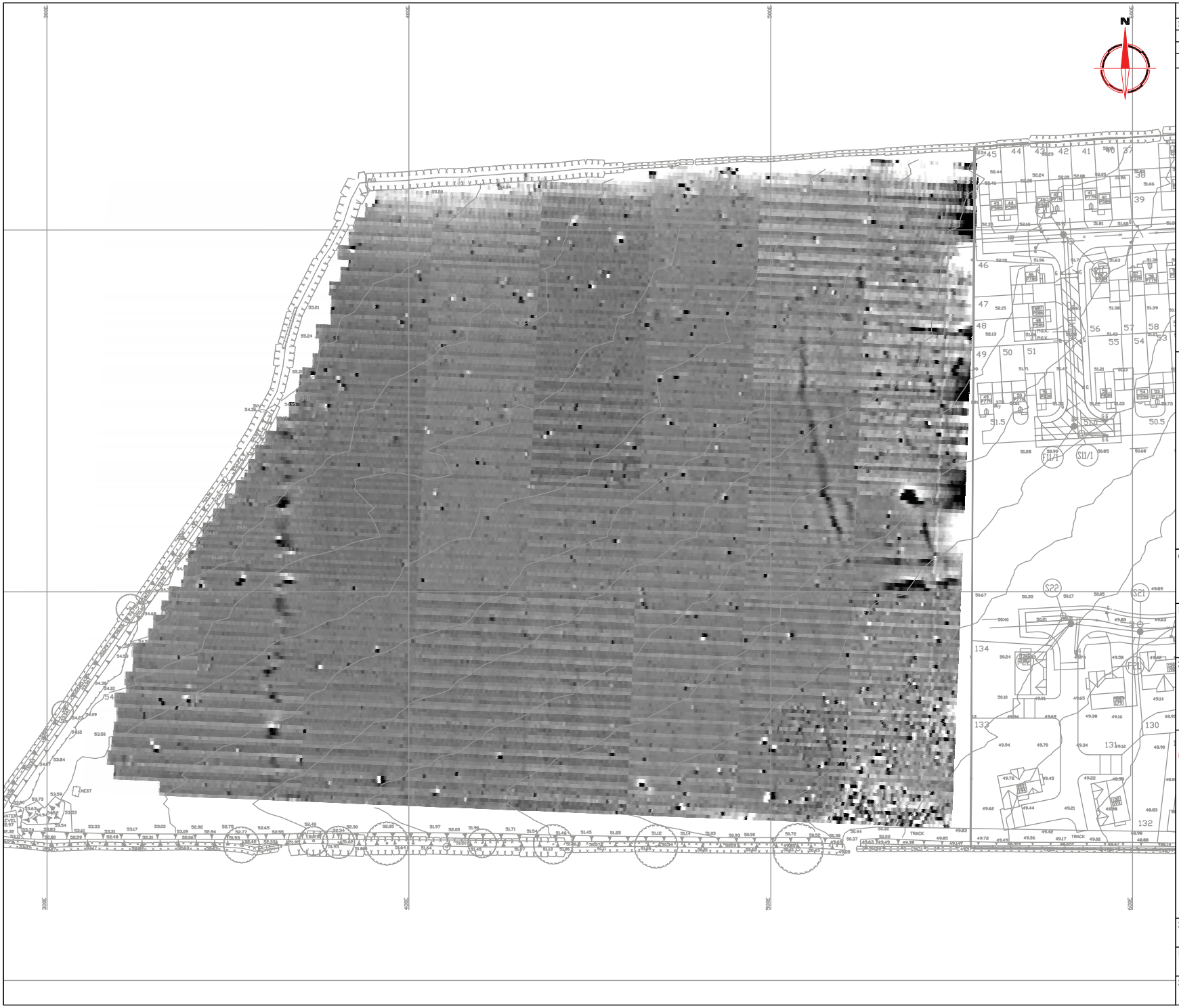

Amendments

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Plotting parameters

Maximum +8nT (black)
Minimum -8nT (white)

Zero Mean

-8nT +8nT

+8nT

-8nT

Client

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GEOPHYSICAL SURVEY - CREED RD, OUNDLE

Subject

PLOT OF RAW GRADIOMETER DATA

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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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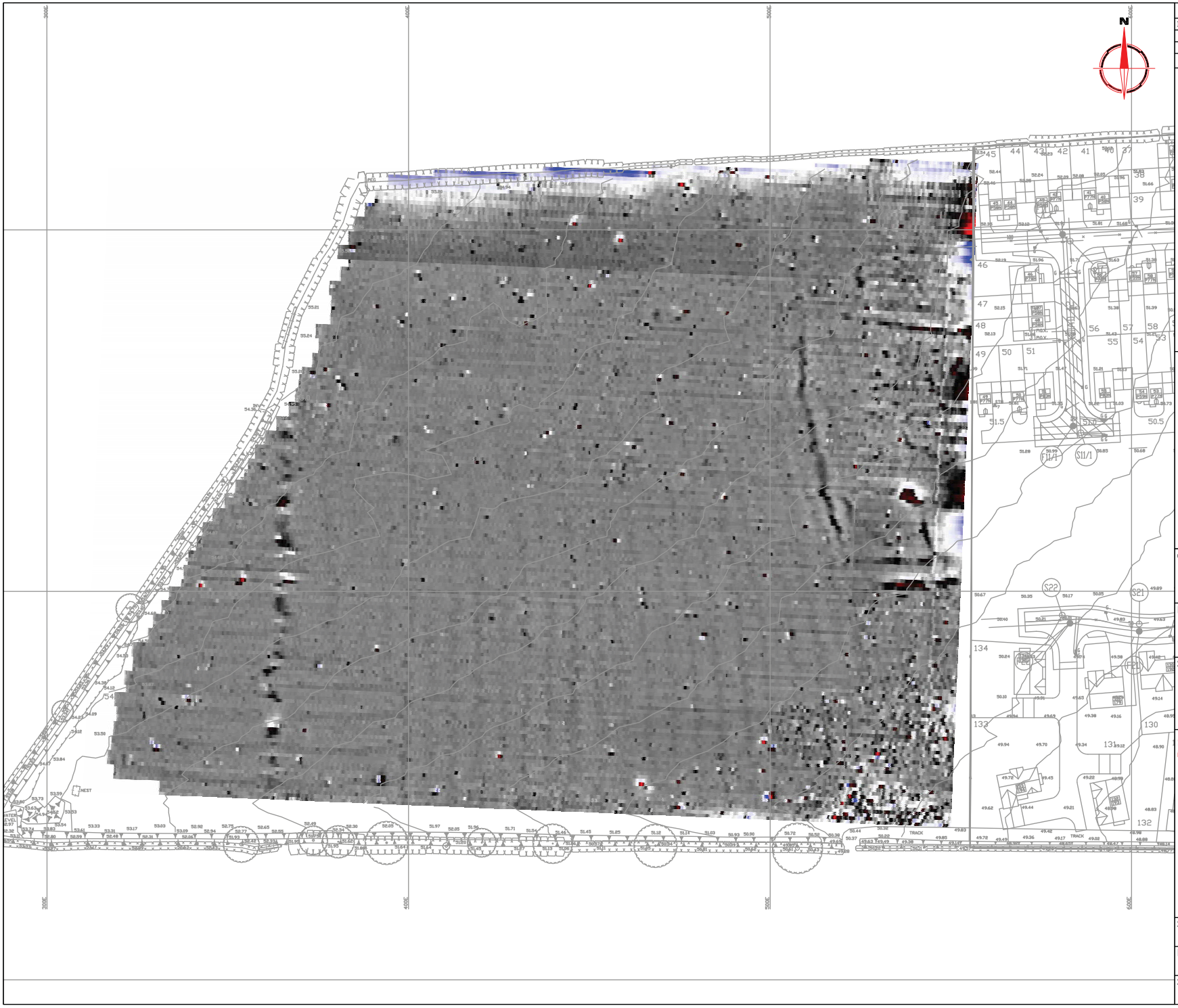

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Plotting parameters

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Minimum -50nT (blue)

Zero Mean

-50nT +50nT

+50nT

-50nT

Client

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GEOPHYSICAL SURVEY - CREED RD, OUNDLE

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COLOUR PLOT OF RAW GRADIOMETER DATA SHOWING EXTREME MAGNETIC VALUES

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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
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Scale 1:1000 0m 10 20 30 40 50

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Survey date	**Drawn by**	**Figure No.**
OCT 2009	CG	04

Amendments

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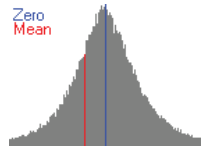

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GEOPHYSICAL SURVEY - CREED RD, OUNDLE

Subject

PLOT OF PROCESSED GRADIOMETER DATA

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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
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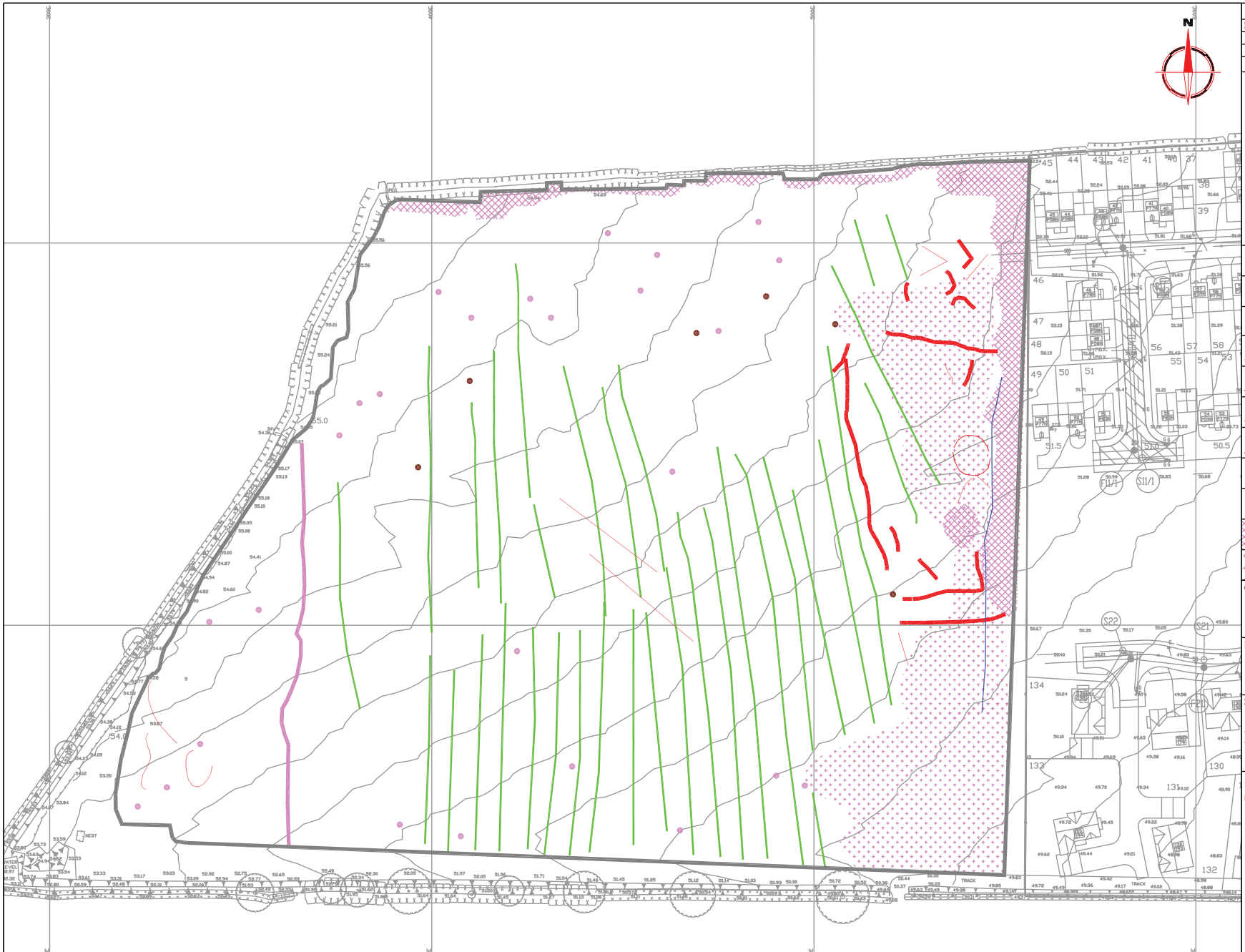

Amendments

Issue No.	Date	Description
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-	-	-

KEY

	Discrete positive anomaly - possible pit
	Positive anomaly with associated negative response - ferrous object
	Magnetic disturbance - associated with pipe/cable
	Negatve linear anomaly - caused by large furrow created by ploughing
	Positive linear anomaly - agricultural mark
	Positive linear anomaly - cut feature of possible archaeological origin
	Positive area anomaly - cut feature of possible archaeological origin
	Negative area anomaly - bank or earthwork of possible archaeological origin
	Magnetic disturbance associated with nearby service or field boundary
	Magnetic debris

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GEOPHYSICAL SURVEY - CREED RD, OUNDLE

Subject

ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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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

Scale 1:1000 — 0m 10 20 30 40 50

Plot	Checked by	Issue No.
A3	PPB	01
Survey date	**Drawn by**	**Figure No.**
OCT 2009	SDH	06