STRATASCAN

Geophysical Survey Report

Bramley to Basingstoke underground cable route

for

Worcestershire County Council (Archaeological Unit)

June 2007

J2345

Simon Haddrell BEng (Hons) AMBCS

REGISTERED IFA ORGANISATION

Document Title: **Geophysical Survey Report**

Client: **Worcestershire County Council (Archaeological Unit)**

Stratascan Job No: **J2345**

Techniques: **Detailed magnetic survey (gradiometry)**

National Grid Ref: **SU 646 596**

Field Team: **Claire Graham BSc (Hons). John Cook BSc (Hons)**

Project Manager: **Simon Stowe BSc. (Hons)**

Report written by: **Simon Haddrell BEng (Hons) AMBCS**

CAD illustration by: **Simon Haddrell BEng (Hons) AMBCS**

Checked by: **Simon Stowe BSc. (Hons)**

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 site is predominantly filled with metallic debris throughout all the areas. A small thermoremnant feature can be seen in area 1 with a few possible features of archaeological origin to the south of the site.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by Worcestershire County Council to undertake a geophysical survey of an area outlined for development.

2.2 Site location

The site is located to the north west of Bramley at OS ref. SU 646 596

2.3 Description of site

The survey area is approximately 3.1 hectares. The current land varies across the site with arable covering area 1, and pasture covering areas 2 and 3.

2.4 Geology and soils

The underlying geology consists of Barton, Bracklesham and Bagshot Beds. (British Geological Survey South Sheet, Fourth Edition Solid, 2001).

The overlying soils are known as Bursledon soils which are typical Eocene and Jurassic loam and clay soils. These consist of deep fine loamy over sandstone with slowly permeable subsoils and slight seasonal waterlogging associated with deep coarse loamy soils variably affected by groundwater. Landslips and associated irregular terrain (Soil Survey of England and Wales, Sheet 6 South East England).

2.5 Site history and archaeological potential

No specific details were available to Stratascan.

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 14 May 2007. Weather conditions during the survey were varied.

3.2 Grid locations

The location of the survey grids was based on the Ordnance Survey National Grid (Figure 1). 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 Earths 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 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 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 and trace plots (Figure 2), together with a greyscale plot of the processed data (Figure 3). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 4).

4 RESULTS

Area 1

Area 1 is filled with anomalies typical of metallic debris. The area of magnetic disturbance and the north of the site is likely to be caused by a nearby electricity pylon in the area. A small dipolar feature can be seen in the south of the area which reads about 50nT. This feature is likely to be a thermoremnant feature such as a kiln. Five discrete positive anomalies have been found in this area with three in close proximity to each other at the northern end of the area. A small negative anomaly can be seen in the centre of the site which may represent a former earthwork or bank. This feature however may be of pedological origin.

Area 2

Area 2 also exhibits a large number of anomalies typical of metallic debris. Areas of magnetic disturbance can be seen at the Northern and southern edges of the area which may be associated with field boundaries. Two small positive linear anomalies can be seen at the south of the site running in a south east to north west direction. These anomalies may represent archaeological features. Nine discrete positive anomalies can be seen throughout the area which have been interpreted as possible pits.

Area 3

Area 3 is predominantly filled with discrete anomalies relating to ferrous objects. The areas of magnetic disturbance on the perimeter of the survey relate to the field boundaries present. Two parallel positive linear anomalies are present in the north east of the site running approximately in a north south orientation. A number of anomalies possibly caused by pits are also present in the southern part of the area. This forms the strongest evidence of surviving archaeology in this area.

5 CONCLUSION

The site as a whole has a large distribution of anomalies typically caused by ferrous objects. A small anomaly is present in the southern section of area 1, which may be thermorenant and hence represent an old kiln. Negative linear and area anomalies which possibly represent old banks or earthworks are observed in the centre of area 1. Discrete positive anomalies typical of pits are located throughout the site in all areas. A small number of positive linear anomalies are evident to the south of area 2 and north of area 3 which may be of an archaeological origin. Overall the survey has shown little evidence of archaeology but further intrusive work may be necessary to confirm the non existence of archaeological features within the site.

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 5 Southwest 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.

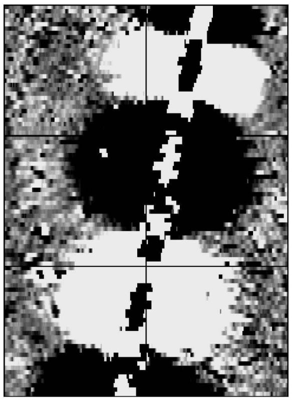
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement 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.

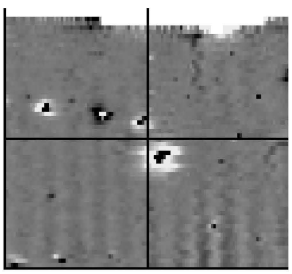
APPENDIX B – Glossary of magnetic anomalies

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

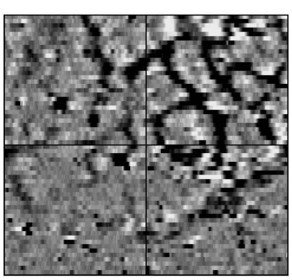


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

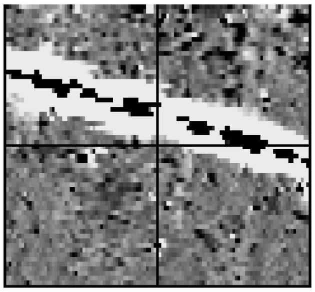
See bipolar and dipolar.

Positive linear



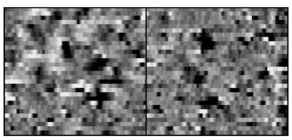
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



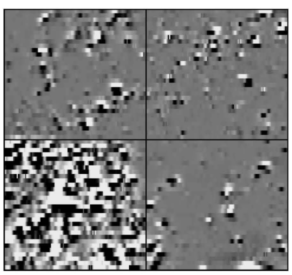
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



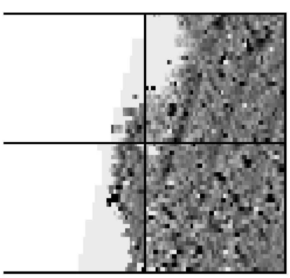
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



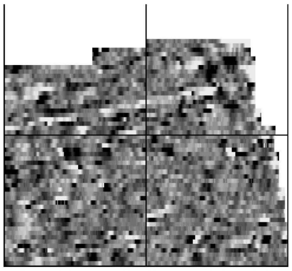
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

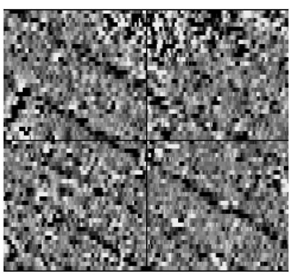
Negative linear



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).

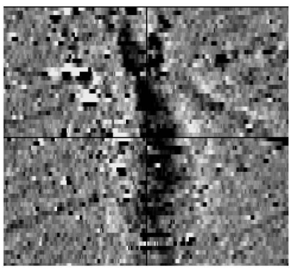
Strength of response

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 $10m^2$ 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.

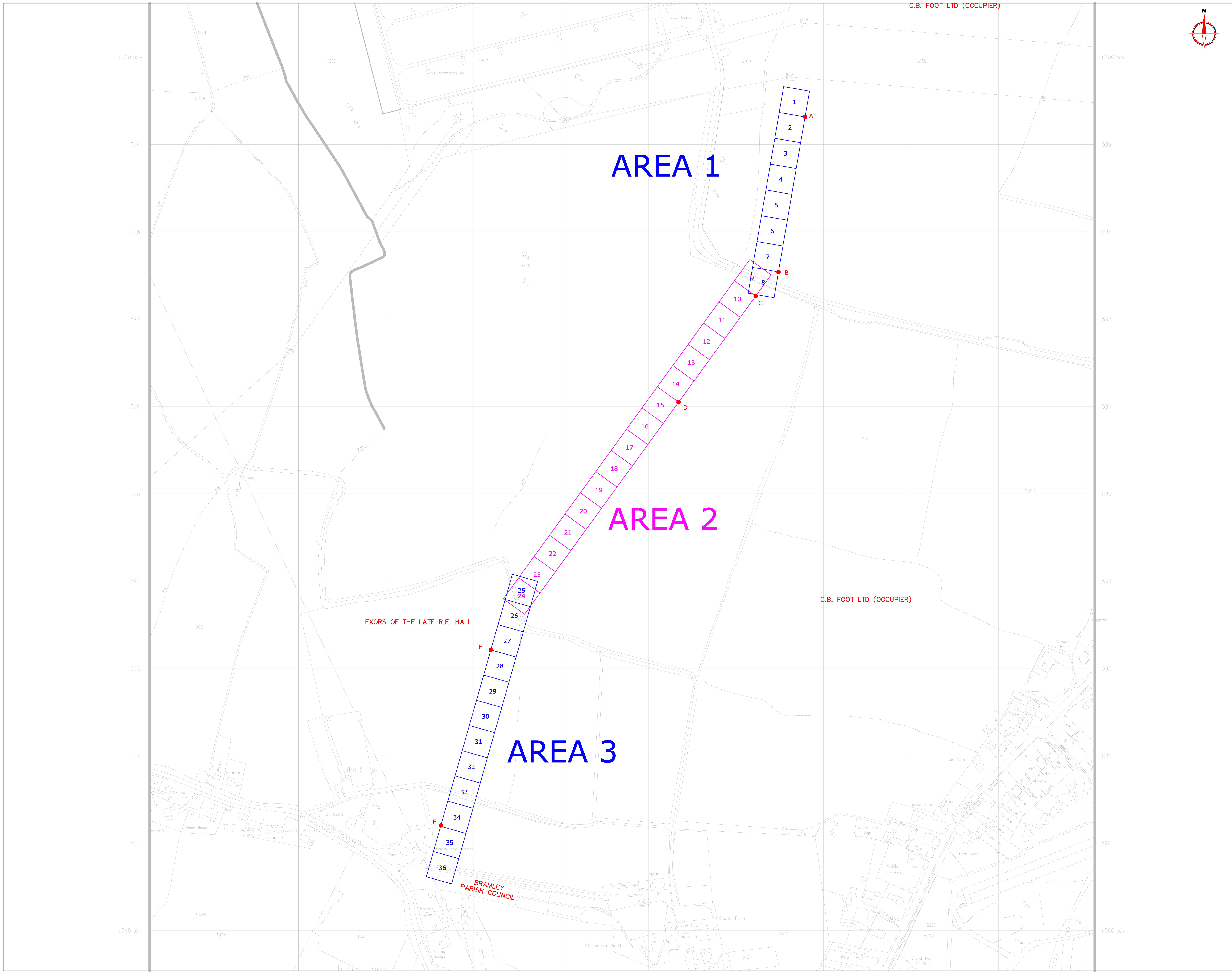
Thermoremnant response

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

Issue No.	Date	Description
-	-	-
-	-	-

REFERENCING

A	464678.880,159931.736
B	464648.426,159754.140
C	464622.422,159726.557
D	464534.276159605.003
E	464319.753,159321.462
F	464262.688,159120.607

KEY

4 GRID NUMBER

Job No. 2345 | Survey Date MAY 2007

Client
WORCESTERSHIRE COUNTY COUNCIL

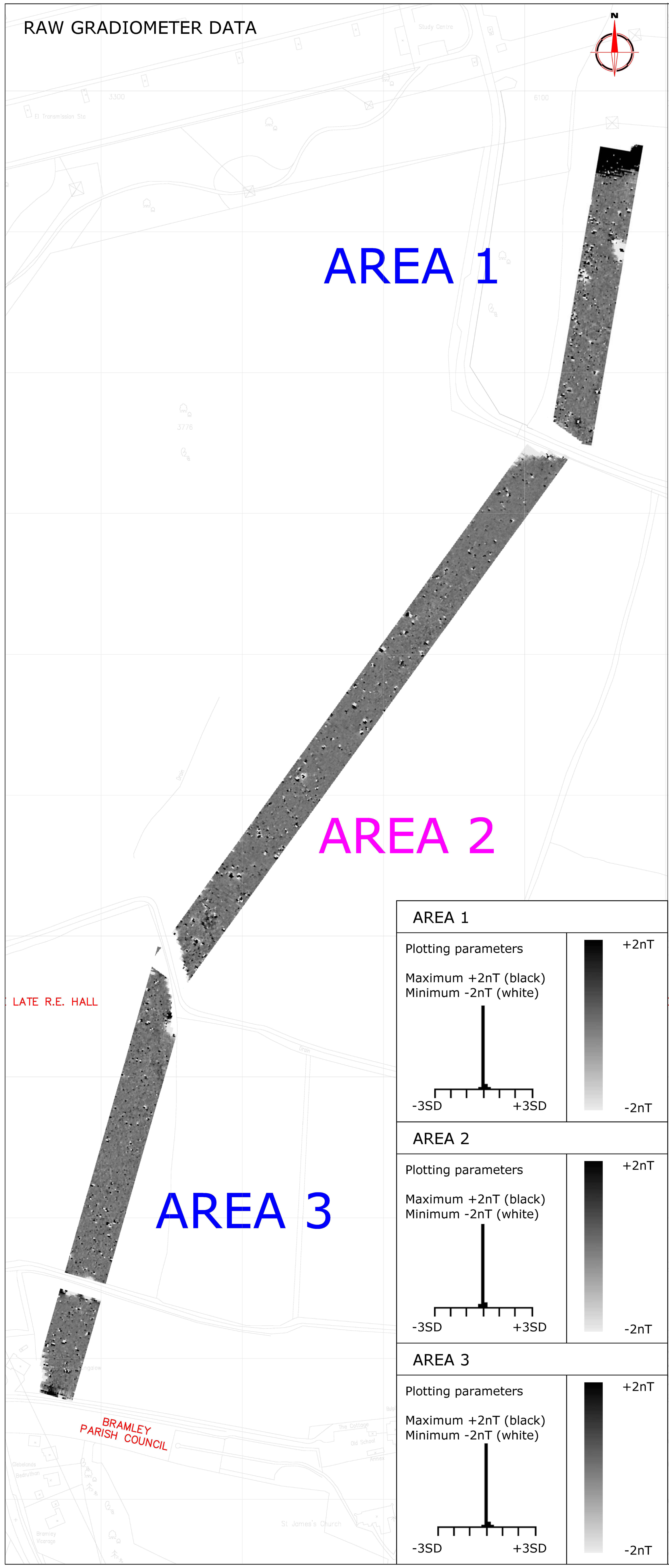
Project Title
BRAMLEY - BASINGSTOKE UNDERGROUND CABLE ROUTE

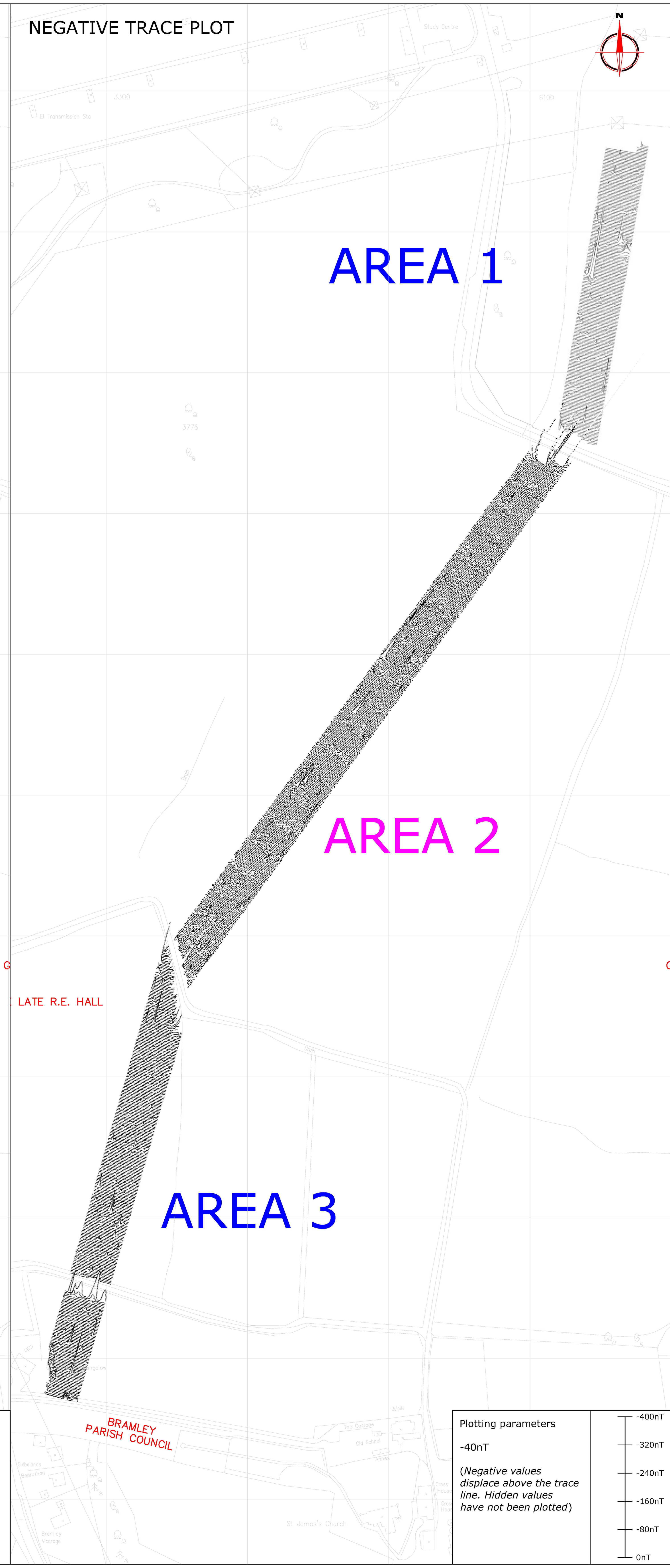
Subject
SITE LOCATION AND SURVEY GRIDS

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 1:2000 (0m 20 40 60 80 100 120m)

Plot	Checked by	Issue No.
A1	PPB	01
Date	**Drawn by**	**Figure No.**
JUN 07	SDH	01





Amendments

Issue No.	Date	Description
-	-	-

Job No. 2345

Survey Date MAY 2007

Client: WORCESTERSHIRE COUNTY COUNCIL

Project Title: BRAMLEY - BASINGSTOKE UNDERGROUND CABLE ROUTE

Subject: RAW GRADIOMETER DATA & TRACE PLOTS

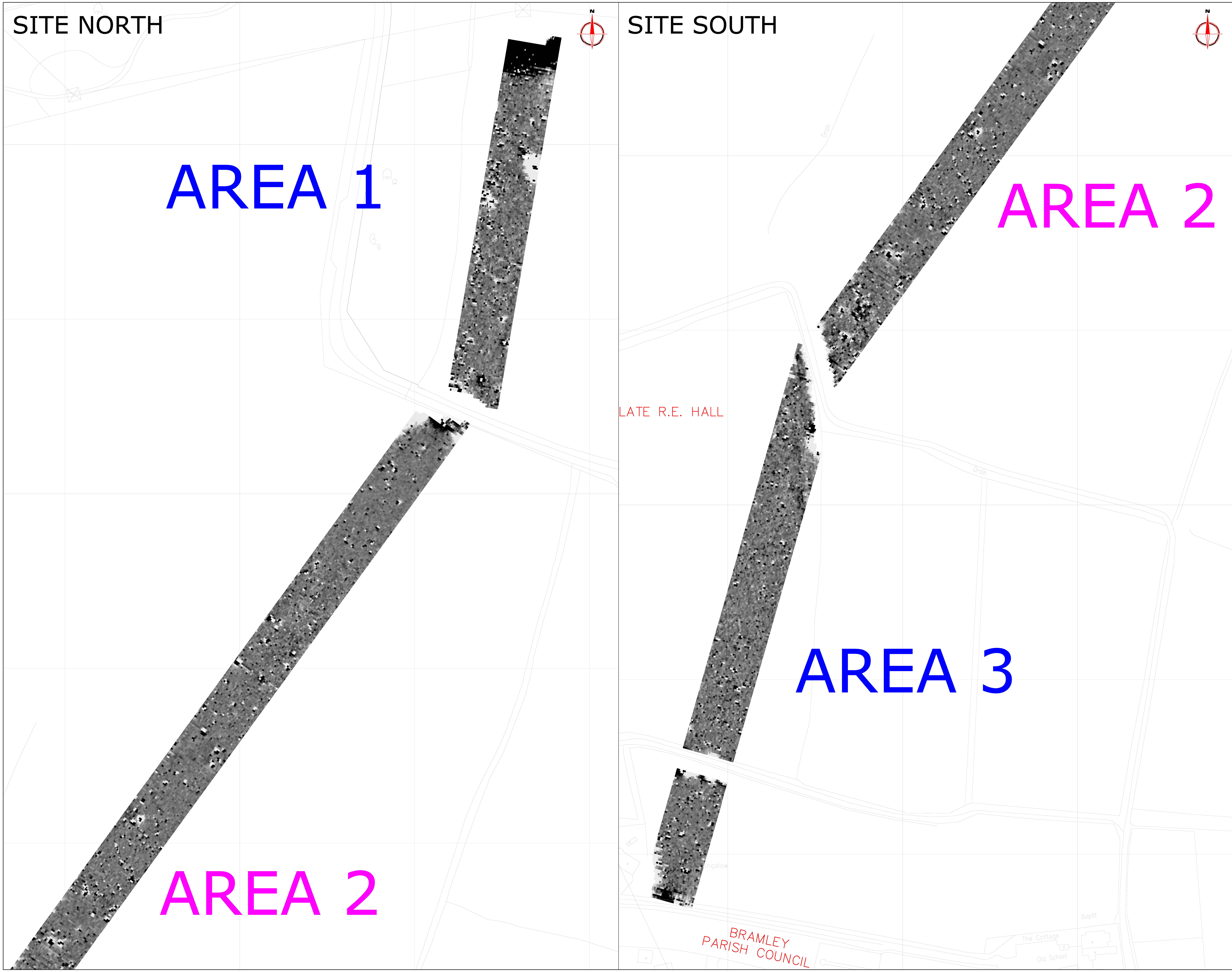
STRATASCAN™
GEOPHYSICS FOR ARCHAEOLOGY AND ENGINEERING
VINEYARD HOUSE
UPPER HOOK ROAD
UPTON UPON SEVERN
UK
WR8 0SA
T: +44 (0)1684 592266
F: +44 (0)1684 594142
E: info@stratascan.co.uk
www.stratascan.co.uk

REGISTERED ORGANISATION IFA

Scale 1:2000 (0m 20 40 60 80 100 120m)

Plot	Checked by	Issue No.
A1	SAS	01

Date	Drawn by	Figure No.
JUN 07	SDH	02



Amendments

Issue No.	Date	Description
-	-	-
-	-	-

AREA 1

Plotting parameters

Maximum +1nT (black)
Minimum -1nT (white)

-3SD +3SD | +1nT -1nT

AREA 2

Plotting parameters

Maximum +1nT (black)
Minimum -1nT (white)

-3SD +3SD | +1nT -2nT

AREA 3

Plotting parameters

Maximum +1nT (black)
Minimum -1nT (white)

-3SD +3SD | +1nT -1nT

Job No. 2345 | Survey Date MAY 2007

Client
WORCESTERSHIRE COUNTY COUNCIL

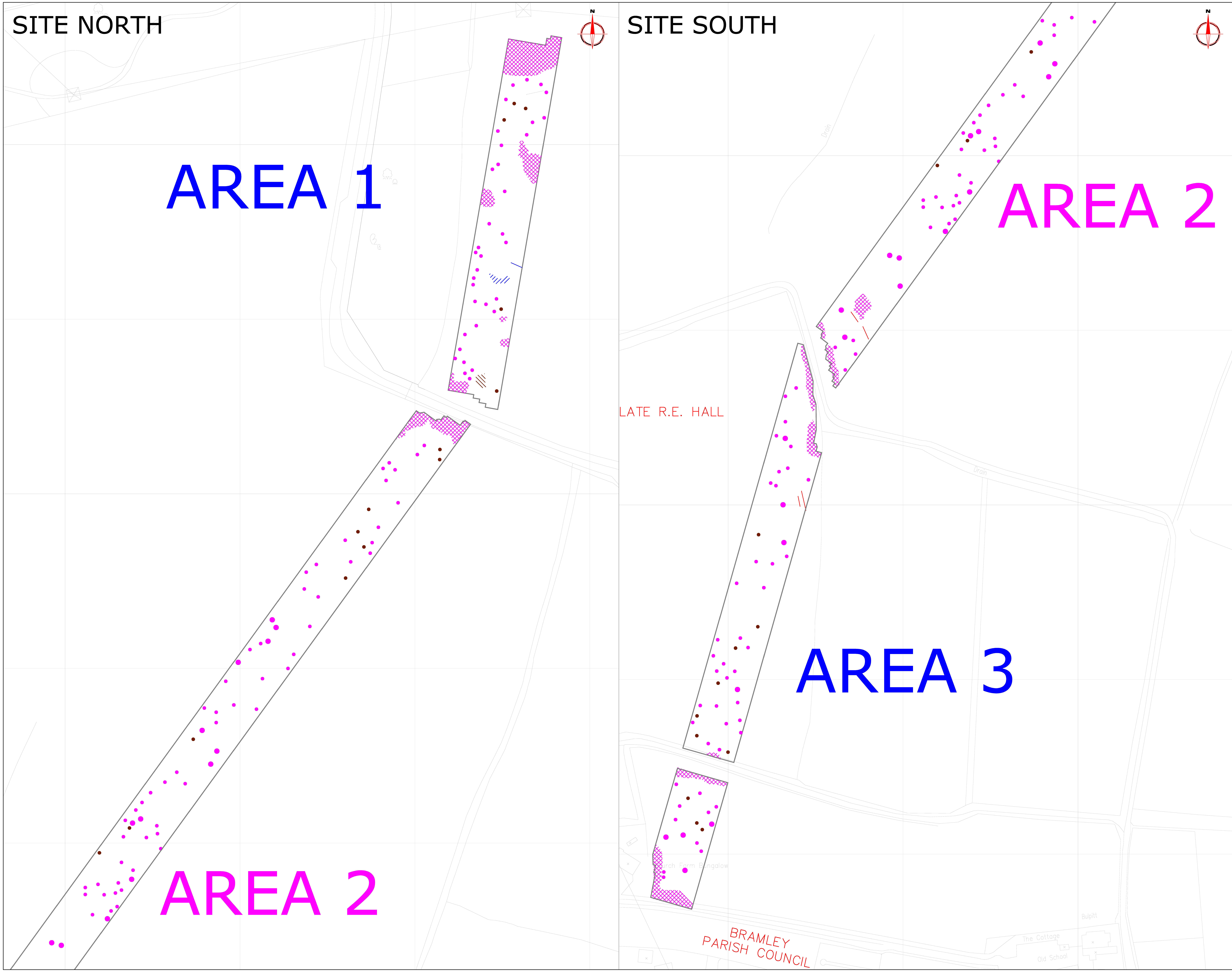
Project Title
BRAMLEY - BASINGSTOKE UNDERGROUND CABLE ROUTE

Subject
PLOT OF PROCESSED GRADIOMETER DATA

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 1:2000 — 0m 20 40 60 80 100 120m

Plot	Checked by	Issue No.
A1	PPB	01
Date	**Drawn by**	**Figure No.**
JUN 07	SDH	03



Amendments

Issue No.	Date	Description
-	-	-
-	-	-

KEY

- Positive linear anomaly - Possible archaeological origin
- Positive Area anomaly - Possible archaeological origin
- Area of magnetic disturbance
- Area of possible thermoremnant disturbance
- Discrete positive anomaly with negative response - ferrous object
- Discrete positive anomaly - possible pit
- Negative linear anomaly - possible former earthwork / bank
- Negative area anomaly - possible former earthwork / bank

Job No. 2345

Survey Date MAY 2007

Client
WORCESTERSHIRE COUNTY COUNCIL

Project Title
BRAMLEY - BASINGSTOKE UNDERGROUND CABLE ROUTE

Subject
ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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
REGISTERED ORGANISATION IFA

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

Plot	Checked by	Issue No.
A1	PPB	01
Date	**Drawn by**	**Figure No.**
JUN 07	SDH	04