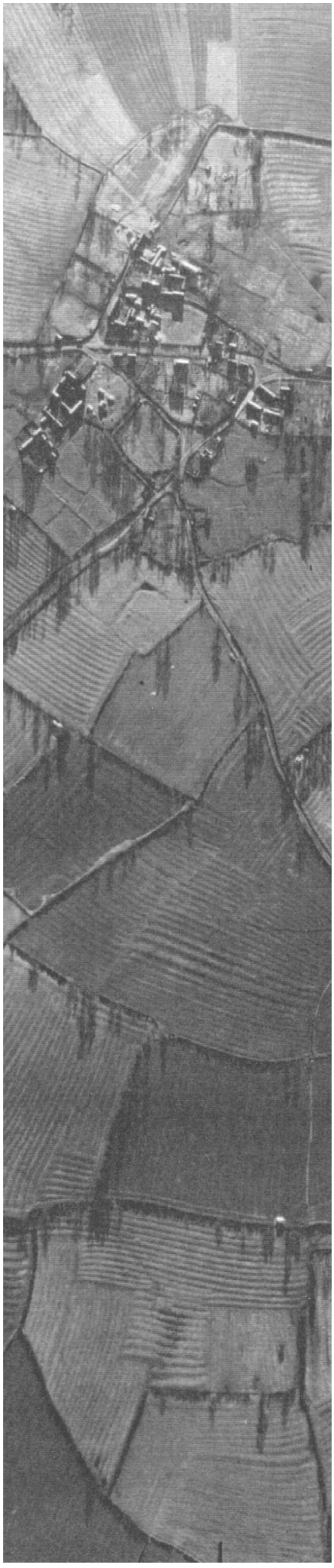

ARCHAEOLOGICAL SURVEYS LTD

GEOPHYSICAL SURVEY REPORT

Land at The Chestnuts
Winscombe
North Somerset

Magnetometer Survey

for

Tuckerwood Developments Ltd

David Sabin and Kerry Donaldson

January 2008

Ref. no. 217

ARCHAEOLOGICAL SURVEYS LTD

Land at The Chestnuts
Winscombe
North Somerset

Magnetometer Survey

for

Tuckerwood Developments Ltd

Fieldwork by David Sabin
Report by David Sabin BSc (Hons) MIFA and Kerry Donaldson BSc (Hons)

Survey date - **16th January 2008**
Ordnance Survey Grid Reference – **ST 423 573**

Printed on 100% recycled paper

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SUMMARY

A magnetometer survey was carried out across an area of land at The Chestnuts, Winscombe, North Somerset. The survey area was restricted by scrub, briars and saplings. The area was also magnetically noisy due to modern dumping of ferrous and magnetically thermoremnant material and the presence of ferrous objects within or immediately adjacent to the survey area. A number of positive and negative anomalies were located although their interpretation is limited. A broad linear response within the northern part of the survey area may represent a former cut ditch-like feature; amorphous anomalies within the south eastern part of the site may represent ground disturbance and/or cut features. The archaeological potential of these anomalies cannot be determined from the results.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Hoddell Associates on behalf of Tuckerwood Developments Ltd to undertake a geophysical survey of an area of land at The Chestnuts off Sidcot Lane in Winscombe that has been outlined for development. This survey formed part of an assessment of any potential archaeology that may be affected by the development.

1.1.2 The survey was requested by North Somerset Council prior to determination of a planning application. No significant archaeological research has been carried out in the area although Roman pottery and burials have been recorded from Sidcot School playing field to the south of the site and the area is known to have been mined for lead in the post medieval period.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site.

1.2.2 Magnetometry is an efficient and effective technique useful for the assessment of the archaeological potential of large areas. The survey and report generally follow the recommendations set out by English Heritage, 1995: *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.*

1.3 Site location, description and survey conditions

1.3.1 The site is located at The Chestnuts off Sidcot Lane, Winscombe, North Somerset. Ordnance Survey grid reference ST 423 573, full reference 342280, 157330.

1.3.2 The geophysical survey covers an area of approximately 1ha of disused grassland, scrub and saplings, see Figure 02. The site appears to have been little used for some time, the grass cover was long and parts of the site were inaccessible due to briar thickets. The area was generally flat although overgrown mounds of dumped soil and other material were present within the western and southern parts of the site. A footpath runs along the southern edge of the site where the land boundary is formed by a stone wall. The northern and eastern boundaries are very overgrown and separate the site from residential areas; to the west the area is accessed from The Chestnuts cul-de-sac and partially bounded by fences defining residential areas.

1.3.3 Material dumped within the western part of the site appeared to contain waste household items and fragmented magnetically thermoremnant material such as brick. Within the north eastern part of the site were the remains of a large concrete mixer, wheelbarrow and other large ferrous objects.

1.3.4 Survey conditions were considered poor mainly due to overgrown vegetation across much of the site. Areas of standing water were encountered within the western part of the survey area. Large ferrous objects within the site, metal signs and a steel gate within the southern boundary were significant sources of magnetic disturbance.

1.4 Site history and archaeological potential

1.4.1 No specific information regarding the archaeological potential of the site was made available to Archaeological Surveys Ltd. Correspondence with the County Archaeologist has indicated the presence of Roman pottery and burials located within Sidcot School playing field (Somerset HER 00238), the exact location is unknown but may refer to the area immediately to the south or south east of the site. Post medieval lead mining activity is also known to have been carried out in the area.

1.5 Geology and soils

1.5.1 The underlying geology is Triassic Dolomitic Conglomerate that contains mineral veins (BGS 1993). The overlying soils across the site are from the Whimple 1 association which are stagnogleyic argillic brown earths. These consist of fine loamy and clayey soils that have slowly permeable subsoils and are prone to slight seasonal waterlogging (Soil Survey of England and Wales 1983).

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features such as pits and ditches can produce magnetic anomalies that can be mapped during magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth or associated with other industrial processes. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT) which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a Bartington Grad601-2 gradiometer. This instrument effectively measures a magnetic gradient between two fluxgate sensors mounted vertically 1m apart. Two sets of sensors are mounted on a single frame 1m apart horizontally. The instrument is extremely sensitive and is able to measure magnetic variation to 0.1nanoTesla (nT). All readings are saved to an integral data logger for analysis and presentation

2.2.2 The instrument is operated according to the manufacturer's instructions with consideration given to the local conditions. An adjustment procedure is required prior to collection of data in order to balance the sensors and remove the effects of the Earth's magnetic field, further adjustment is required during the survey due to instrument drift often associated with temperature change. It is often very difficult to obtain optimum balance for the sensors due to localised magnetic vectors that can be associated with large ferrous objects, geological/pedological features, 'magnetic' debris within the topsoil and natural temperature fluctuations. Imperfect balance results in a heading error often visible as striping within the data; this can be effectively removed by software processing and generally has little effect on the

data unless extreme. Archaeological Surveys use a non-magnetic tripod with an additional supporting structure to raise the instrument during the set-up procedure, this has been found to improve the sensor balance.

2.2.3 The Bartington gradiometer undergoes regular servicing and calibration which is carried out by the manufacturer. A current assessment of the instrument is shown in Table 1 below.

Date of calibration/service	21st May 2007
Sensor type	Bartington Grad - 01 – 1000 Nos. 084 and 085
Bandwidth	12Hz (100nT range) both sensors
Noise	<100pT peak to peak
Adjustable errors	<2nT

Table 1: Bartington fluxgate gradiometer sensor calibration results

The instrument was considered to be in good working order prior to the survey with no known faults or defects.

2.2.4 Data were collected at 0.25m centres along traverses 1m apart. The survey area was separated into 30m by 30m grids giving 3600 recorded measurements per grid. This sampling interval is very effective at locating archaeological features and is the recommended methodology for archaeological prospection (English Heritage, 1995).

2.2.5 The survey grids were set out to the Ordnance Survey OSGB36 datum using a Penmap RTK GPS. The GPS is used in conjunction with Leica's Smartnet service where positional corrections are sent via a mobile telephone link. Positional accuracy of around 10 – 20mm is possible using the system. A base map for the survey results was also created using the RTK GPS.

2.2.6 The fixed orientation of survey grids based on the OSGB36 datum was considered appropriate given that the orientation of land boundaries and obstructions was variable and consequently partial survey grids were unavoidable. In addition there is an optimum north – south traverse direction for magnetic survey (English Heritage,1995). Survey in this direction exploits the greater contrast of magnetic features which is a function of their presence within the Earth's magnetic field. A fixed grid across the site also simplifies its relocation should that be required.

2.3 Data processing and presentation

2.3.1 Magnetometry data downloaded from the Grad 601-2 data logger are analysed and processed in specialist software known as ArcheoSurveyor. The software allows greyscale and trace plots to be produced for presentation and display. Survey grids are assembled to form an overall composite of data (composite file) creating a dataset of the complete survey area. Appendix B

contains specific information concerning the survey and data attributes and is derived directly from ArcheoSurveyor, this should be used in conjunction with information provided by Figure 02.

2.3.2 Only minimal processing is carried out in order to enhance the results of the survey for display. Raw data are always analysed as processing can modify anomalies. The following schedule sets out the data and image processing used in this survey:

- clipping of processed data at ±3nT to enhance low magnitude anomalies,
- clipping of trace plots at ±100nT in order to minimise strong readings obscuring low magnitude responses,
- de-stagger is used to enhance linear anomalies,
- zero median/mean traverse is applied in order to balance readings along each traverse.

(Reference should be made to Appendix B for details on the processing used).

Data processing explanation notes:

Clipping
Clipping replaces the values outside the specified minimum and maximum with those values. The process is useful for displaying detail as extreme values are removed allowing greyscale shades to be allocated to a narrower range of values which improves the definition of anomalies.

Zero Median/Mean Traverse
The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise slight differences between the set-up and stability of gradiometer sensors and can remove striping.

De-stagger
Compensates for small positional errors within data collection by shifting the position of the readings along each traverse by a specified amount.

2.3.3 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly with an appropriate reference number is set out in list form within the results (Section 3) to allow a rapid assessment of features.

2.3.4 The main form of data display used in this report is the greyscale plot. Raw magnetic data are also displayed as a trace plot. An abstraction and interpretation plot defines anomalies using coloured polylines and polygons.

2.3.5 Graphic raster images in Bitmap format are initially prepared in ArcheoSurveyor. Regardless of survey orientation, data captured along each traverse is displayed and processed by ArcheoSurveyor from left to right. This corresponds to a direction of south to north in the field for this survey. Prior to displaying against base mapping, raster graphics require a rotation of 90° anticlockwise to restore north to the top of the image. Greyscale images are rotated using AutoCAD, traceplots are rotated using ArcheoSurveyor. Rotated trace plots are derived from interpolated datasets and can be considered as representative only as the raw data will have been modified to a minor degree.

2.3.6 The raster images are combined with base mapping using AutoCAD LT 2007 creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method etc.. A digital archive including raster images is produced with this report allowing separate analysis if necessary, see Appendix C.

3 RESULTS

3.1 General overview

3.1.1 The detailed magnetic survey was carried out over approximately 1ha where accessible. Geophysical anomalies located can be generally classified as positive and negative linear anomalies of an uncertain origin, positive and negative areas of uncertain origin, areas of magnetic debris and disturbance and strong discrete dipolar anomalies relating to ferrous objects. Anomalies located have been numbered and will be discussed below.

3.1.2 A number of factors may affect the quality of the dataset: ground conditions were very poor preventing smooth and even data collection, modern ferrous debris and ferrous objects have caused significant areas of magnetic disturbance possibly obscuring low magnitude anomalies and the widespread presence of magnetic vectors may have influenced the instrument set up procedure. In order to optimise data quality a number of steps were taken to account for the above: pacing along each traverse was slowed to account for poor conditions underfoot and allow steady and even data capture, ferrous objects were avoided as far as possible and their position noted and during the set up procedure the instrument was raised above the ground surface in a magnetically quiet location.

3.1.3 The listing of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross reference to the abstraction and interpretation plot.

Sub-headings are then used to group anomalies with similar characteristics for each survey area.

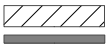
Anomalies with an uncertain origin

Positive anomalies
Negative anomalies

The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features but equally relatively modern features, geological/pedological features and agricultural features should be considered.

Anomalies with a modern origin

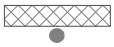
Magnetic disturbance
Strong multiple dipolar linear anomaly - pipeline/service



The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present.

Anomalies associated with magnetic debris

Magnetic debris
Strong discrete dipolar anomaly



The response often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. Magnetic debris often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.

3.2 List of anomalies

Anomalies with an uncertain origin

(1) – A positive broad linear anomaly located in the northern part of the site may represent a ditch-like feature. The anomaly may extend further to the east, however, this is unclear due to severe magnetic disturbance.

(2) – A broad negative response located adjacent to anomaly (1) may be associated. Negative response would suggest material of low magnetic susceptibility, often this is subsoil; it is possible that the material is upcast from the formation of (1).

(3) – A negative linear anomaly with a similar orientation to (2) may be associated.

(4) – A zone of amorphous although discrete positive anomalies and a similar negative response located within the south eastern part of the site. The zone may indicate ground disturbance with the possibility of in-filled cut features (positive anomalies); the variable responses may, however, indicate an area of dumping.

(5) – Parallel positive linear anomalies of very low magnitude may represent cut features although have a similar appearance to cultivation marks.

(6) – A zone of negative response may represent dumped soil with low magnetic susceptibility.

Anomalies associated with magnetic debris

(7) – A large area of magnetic debris was located within the western part of the survey area. This is a response to ferrous and magnetically thermoremnant material dumped onto the site.

Anomalies with a modern origin

(8) – A zone of magnetic disturbance close to the south eastern corner of the site may be associated with ferrous objects beyond the limit of the survey area.

(9) – Magnetic disturbance along the eastern side of the survey area has been caused by dumped ferrous objects and possibly services or fencing.

4 CONCLUSION

4.1

4.1.1 The area of magnetometry was restricted by the ground cover encountered on the site and the data have been severely disturbed by zones of magnetic debris and disturbance. The survey located a number of anomalies of uncertain origin; interpretation is restricted due to a lack of identifiable morphological characteristics. Although a significant proportion of the site shows some magnetic disturbance, it is considered likely that significant anomalies would be visible if they were present in those areas.

4.1.2 A positive anomaly within the northern part of the site (anomaly 1, Figure 05) may be consistent with a cut ditch-like feature, however, the archaeological potential of the anomaly is unknown. Irregular or amorphous anomalies within the south eastern part of the site (anomalies 4, Figure 05) may infer a degree

of ground disturbance and/or the presence of cut features, no further comment on their archaeological potential is possible.

5 REFERENCES

British Geological Survey, 1993. *Bristol District, England and Wales Special Sheet, Solid and Drift Edition, One -Inch Series.*

English Heritage, 1995. *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.*

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 South West England.*

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – survey and data information

Processed magnetometry data

Filename: Mag-proc5.xcp
Instrument Type: Grad 601 (Magnetometer)
Units: nT
Surveyed by: on 16/01/2008
Assembled by: on 16/01/2008
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 0.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 360 x 90
Survey Size (meters): 90 m x 90 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.60
Mean: 0.07

Processes: 12
1 Base Layer
2 Clip from -10 to 10
3 DeStripe Median Traverse: Grids: 05.xgd
4 DeStripe Median Traverse: Grids: 06.xgd
5 De Stagger: Grids: 08.xgd Mode: Outbound By: 2 intervals
6 Clip from -5 to 5
7 DeStripe Mean Traverse: Grids: 02.xgd Threshold: 0.5 SDs
8 DeStripe Mean Traverse: Grids: 03.xgd Threshold: 0.5 SDs
9 DeStripe Mean Traverse: Grids: 08.xgd Threshold: 2.5 SDs
10 DeStripe Mean Traverse: Grids: 01.xgd 04.xgd 07.xgd Threshold: 1 SDs
11 Clip from -5 to 5
12 Clip from -3 to 3

Source Grids: 8
1 Col:0 Row:0 grids\01.xgd
2 Col:0 Row:1 grids\02.xgd
3 Col:0 Row:2 grids\03.xgd
4 Col:1 Row:0 grids\04.xgd
5 Col:1 Row:1 grids\05.xgd
6 Col:1 Row:2 grids\06.xgd
7 Col:2 Row:0 grids\07.xgd
8 Col:2 Row:1 grids\08.xgd

Appendix C – digital archive

Survey results are produced in hardcopy using A4 for text and A3 for plots (all plots are scaled for A3). In addition digital data created during the survey are supplied on CD. Further information on the production of the report and the digital formats involved in its creation are set out below.

This report has been prepared using the following software on a Windows XP platform:

- ArcheoSurveyor version 2.2.0.0 (geophysical data analysis),
- AutoCAD LT 2007 (report figures),
- OpenOffice.org 2.3.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive).

Digital data are supplied on CD ROM which includes the following files:

- ArcheoSurveyor grid and composite files for all geophysical data,
- CSV files for processed composites,
- geophysical composite file graphics as Bitmap images,
- AutoCAD DWG files in 2000 and 2007 versions,
- report text as OpenOffice.org ODT file,
- report text as Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures.

The CD ROM structure is formed from a tree of directories under the title J217 Winscombe – CD. Directory titles include Data, Documentation, CAD, PDFs and Photos. Multiple directories exist under Data and hold Grid, Composite and Graphic files with CSV composite data held in Export.

The CAD file contains externally referenced graphics that may be rotated, see 2.3.5, with separate A3 size layouts for each figure. Layouts are fixed using frozen layers and named views allowing straightforward plotting or analysis on screen. (Note – CAD files are prepared using AutoCAD's e Transmit function to produce a directory containing the digital drawing along with any externally referenced graphics which may need reloading).

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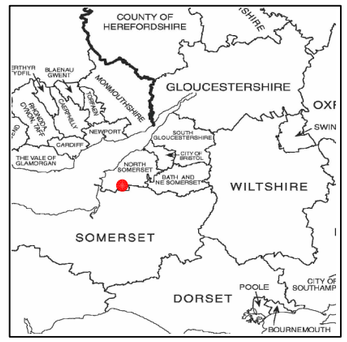
Geophysical Survey
Land at The Chestnuts
Winscombe
North Somerset

Map of survey area



● Survey location

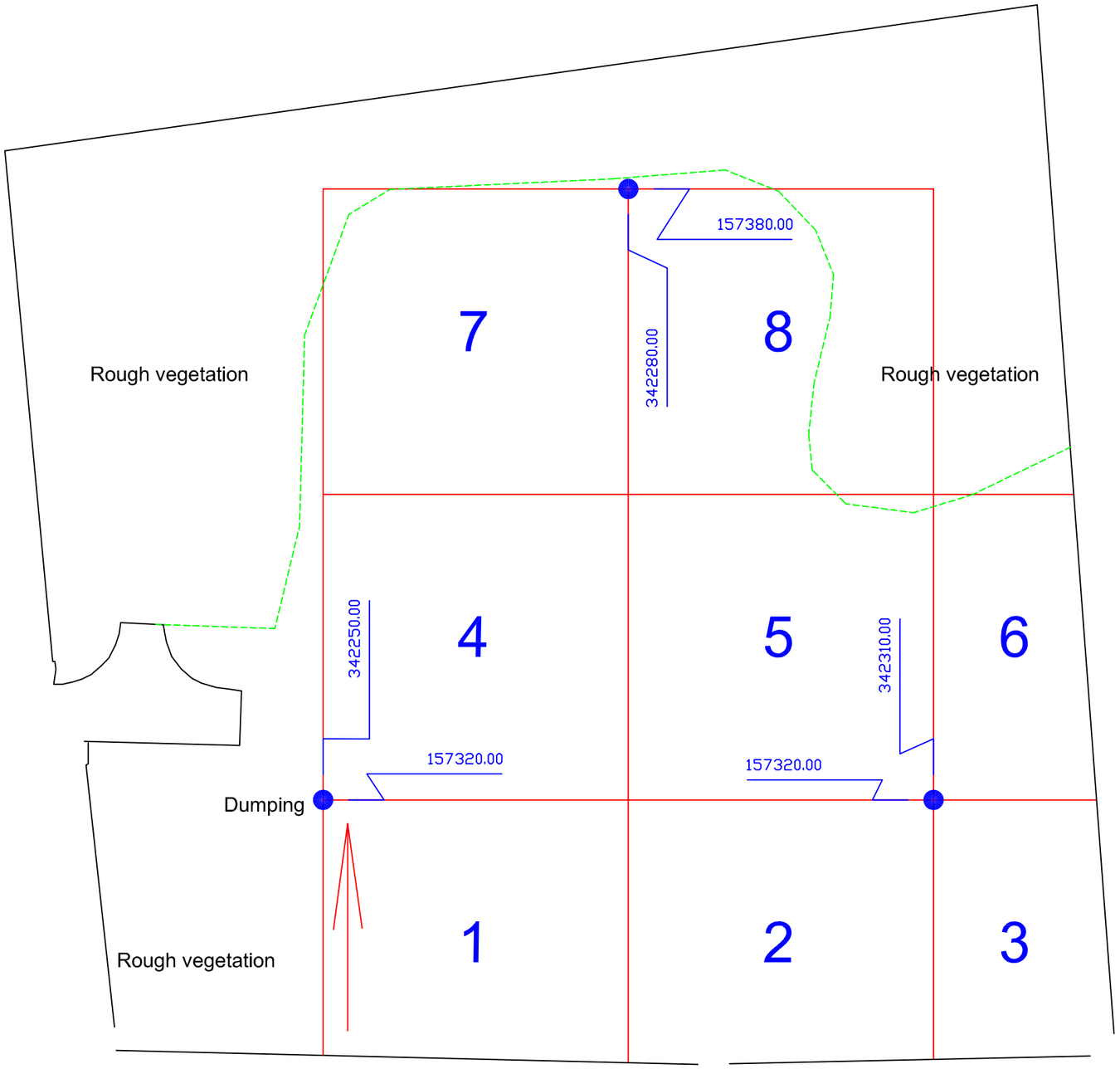
Site centred on OS NGR
ST 423 573

SCALE 1:50 000

0m 1000m 2000m

SCALE TRUE AT A3

FIG 01



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Geophysical Survey
Land at The Chestnuts
Winscombe
North Somerset

Referencing information

Grid coordinates based on Ordnance Survey OSGB36 datum

Grids set out using RTK GPS with Leica Smartnet correction data RTCMv2 format

Survey grid size = 30m

Survey start and traverse direction

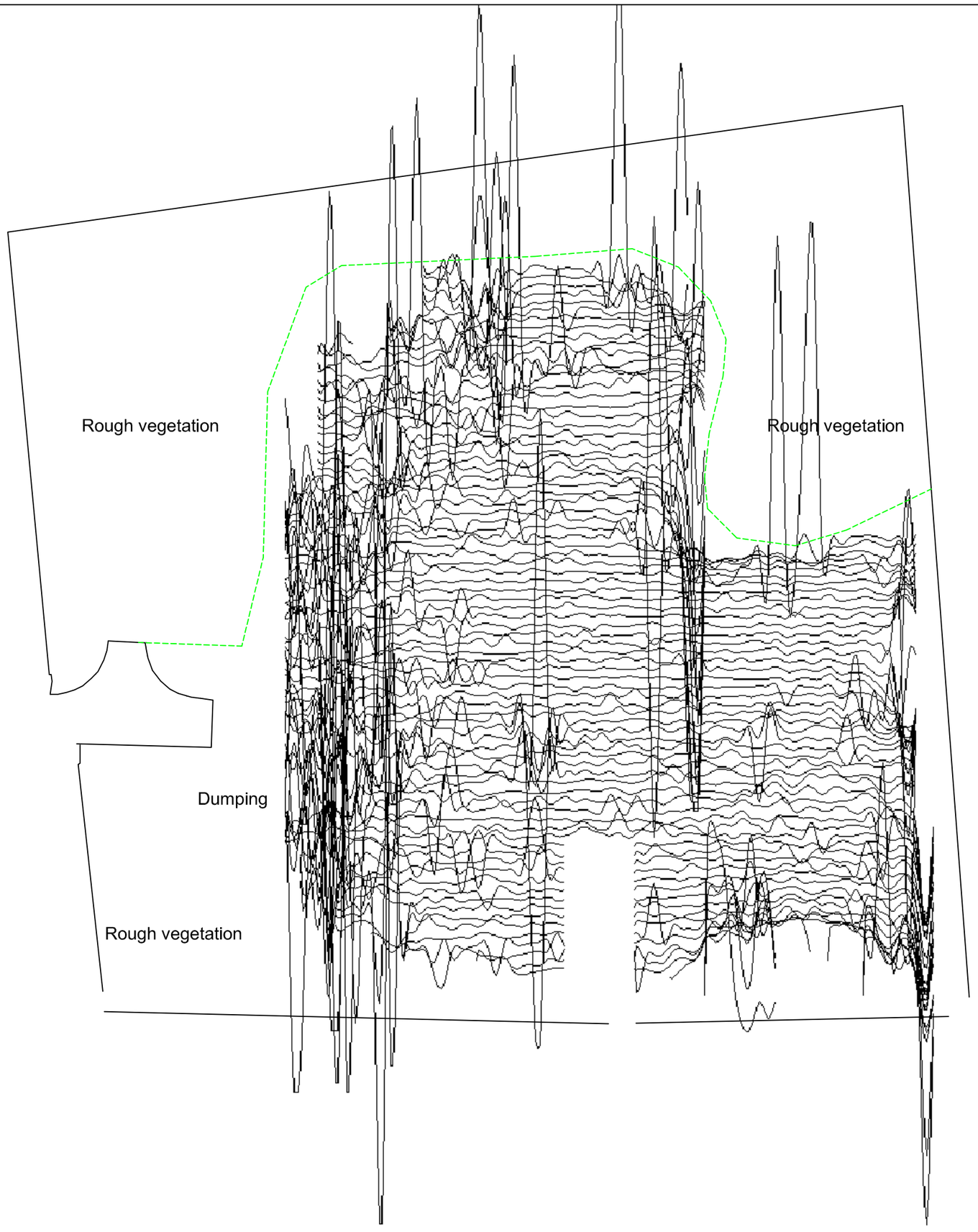
1 Grid reference number and filename

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

FIG 02



N

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Geophysical Survey
Land at the Chestnuts
Winscombe
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Traceplot of raw magnetometer data

+25nT
+12.5nT
0nT
-12.5nT
-25nT

Approx 12.5nT/ cm vertical displacement.

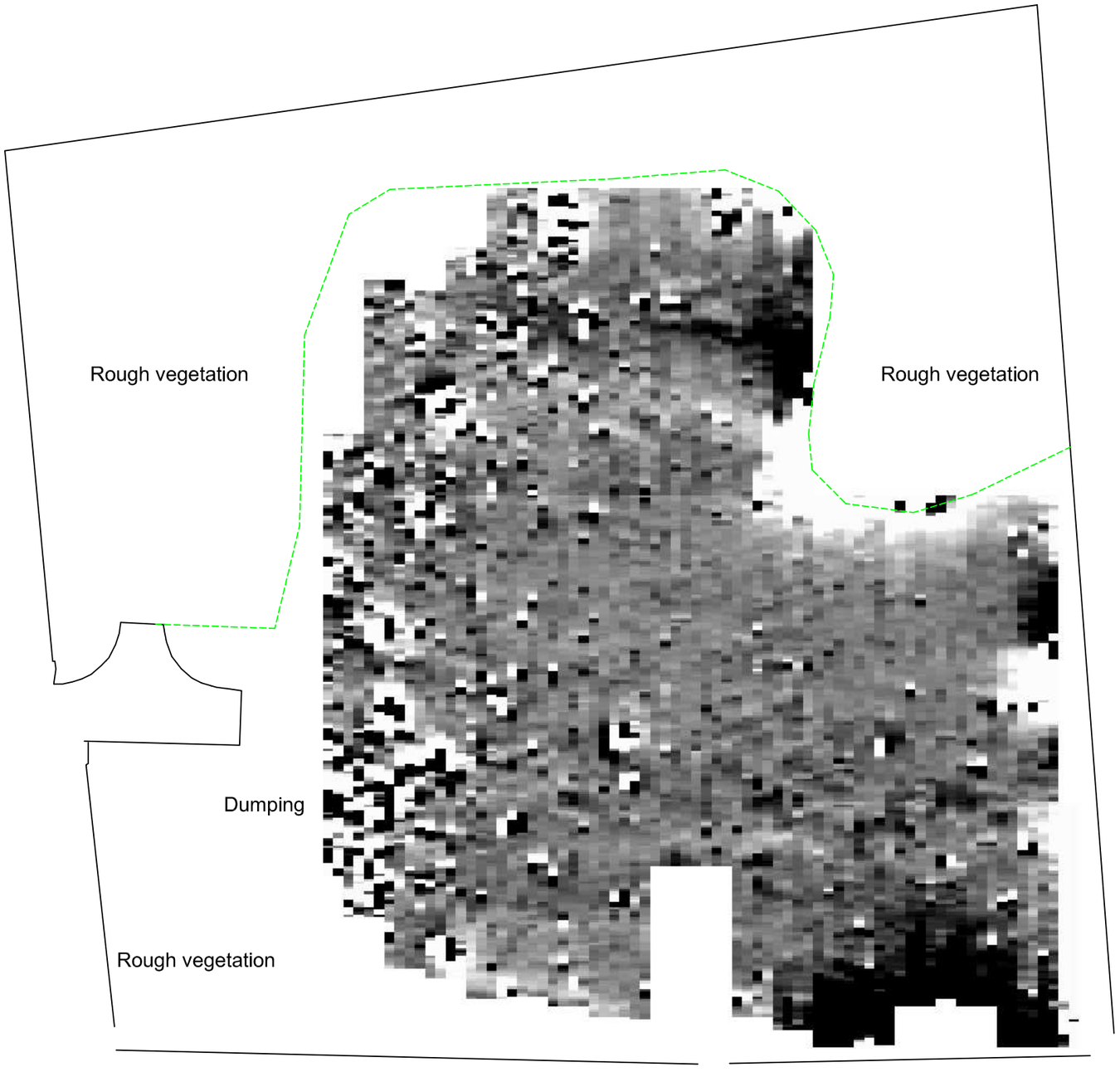
Data have been clipped at ± 100nT.

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

FIG 03



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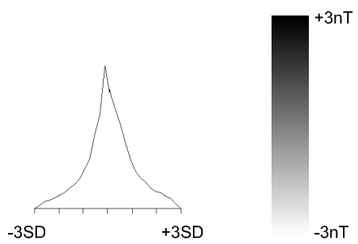
Greyscale plot of processed magnetometer data



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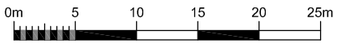

SCALE TRUE AT A3

FIG 04

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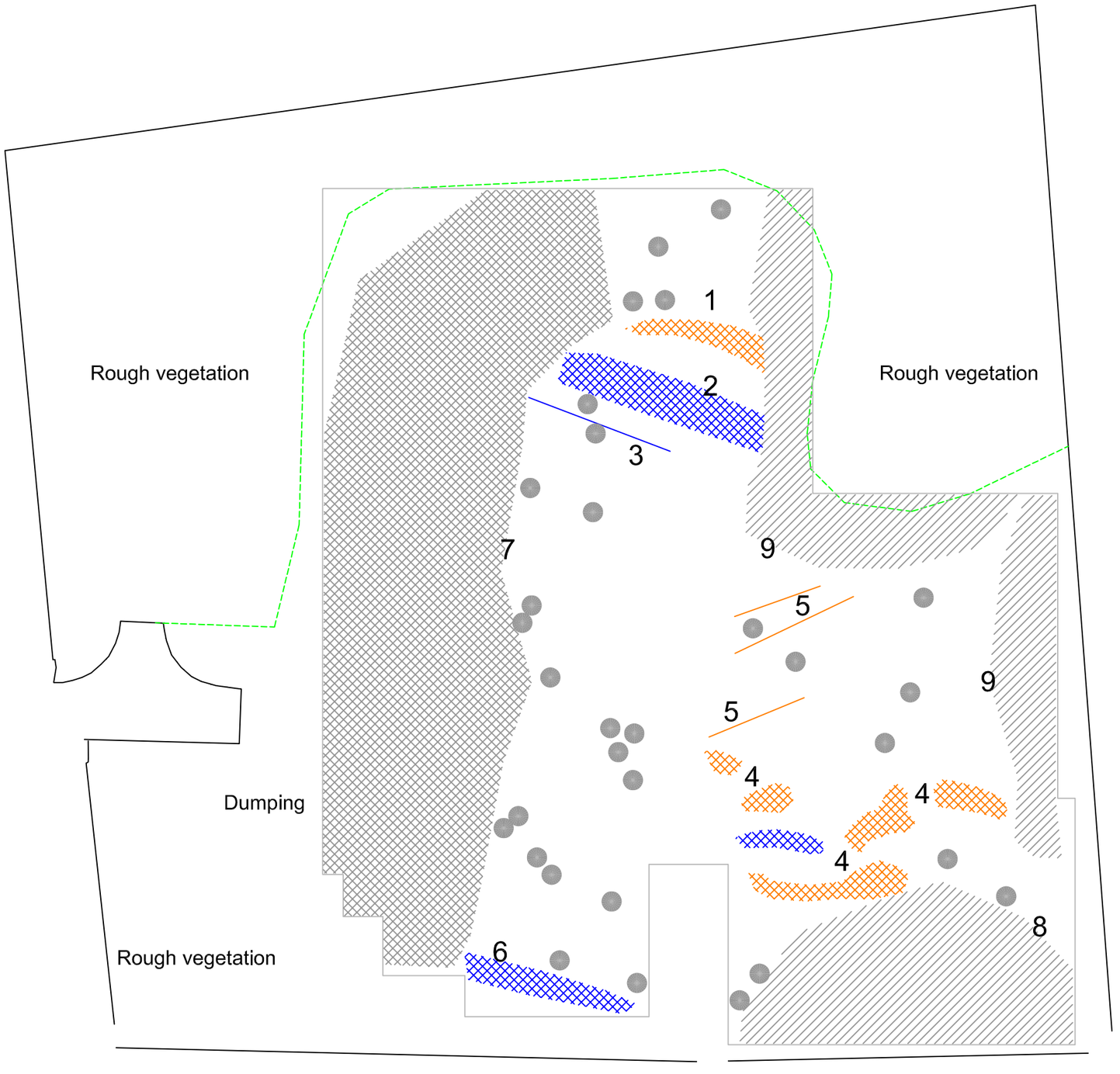

Abstraction and interpretation of magnetometer anomalies

- Positive linear anomaly - of uncertain origin
- Negative linear anomaly - of uncertain origin
- Negative anomaly - uncertain origin
- Positive anomaly - uncertain origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

FIG 05