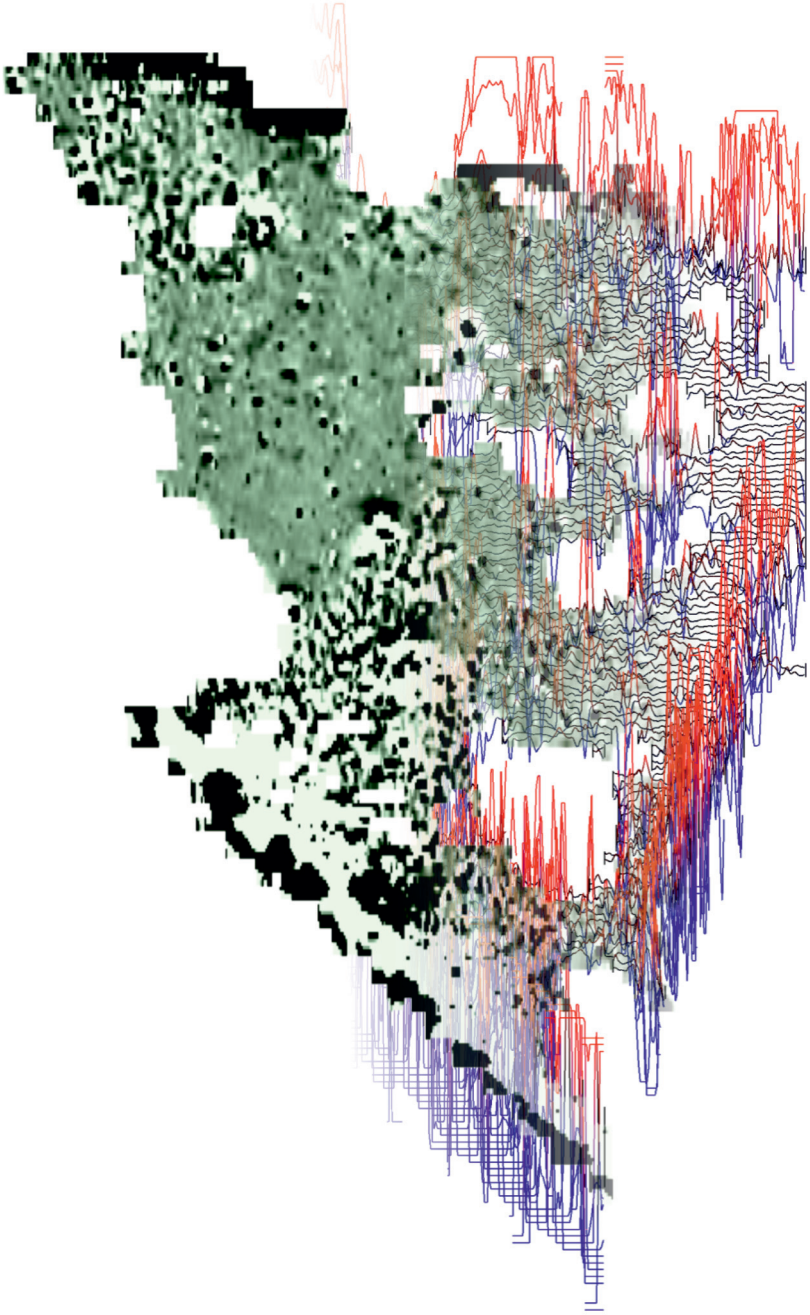
Wessex Archaeology

Land at Doncaster Racecourse
Doncaster,
South Yorkshire

Detailed Gradiometer Survey Report



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May 2012

LAND AT DONCASTER RACECOURSE
DONCASTER
SOUTH YORKSHIRE

Detailed Gradiometer Survey Report

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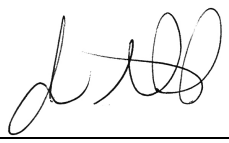
01	E	BCU	APN		10/05/12	X:\PROJECTS\84780\GEOPHYSICS\REPORT\84780_REPORT.DOC

I= Internal Draft E= External Draft F= Final

LAND AT DONCASTER RACECOURSE
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Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land at Doncaster Racecourse, hereafter 'the Site' (NGR 460040 402590), in April 2012. The project was commissioned by Sheffield City Council with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features at the site as part of an ongoing programme of archaeological investigation around the recent find of a coin hoard.

The site was located some 2km south of Doncaster, South Yorkshire, in a clearing on the southern edge of Doncaster Racecourse. The gradiometer survey covered approximately 1.2ha, and has demonstrated the presence of a number of anomalies of possible archaeological interest within the survey area; parts of the site were not suitable for survey through the presence of dense undergrowth and trees.

A number of ditch-like and pit-like anomalies were detected in the immediate vicinity of the hoard findspot. Whilst none of the responses were definitively archaeological in origin, it is possible that they indicate a cluster of features, which may be contemporary with the deposition of the hoard.

Further isolated pit-like and ditch-like anomalies were seen elsewhere within the dataset, along with a number of weak linear trends.

Magnetic disturbance resulting from the presence of the racecourse, Bawtry Road to the south of the site, and two possible modern services extends some way into the dataset. Along with isolated ferrous responses, this magnetic disturbance will have had the effect of masking weaker archaeological anomalies and makes interpretation of the dataset less conclusive.

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Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by South Yorkshire Archaeology Services, part of Sheffield City Council, and the assistance of Andy Lines is gratefully appreciated in this regard.

The fieldwork was directed by Mike Hartwell and assisted by Martin Huggon and Philip Roberts. Ben Urmston processed the geophysical data and wrote this report. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Andrew Norton.

LAND AT DONCASTER RACECOURSE
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SOUTH YORKSHIRE

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology (WA) was commissioned by Sheffield City Council to carry out a geophysical survey of land at Doncaster Racecourse, near Doncaster, South Yorkshire (**Figure 1**), hereafter 'the Site' (NGR 460040 402590). The survey forms part of an ongoing programme of archaeological work at the Site following the discovery of a coin hoard.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the Site, particularly anomalies that may be associated with the hoard.

1.1.3 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The Site lies 2km east of Doncaster, and comprises a clearing within an area of scrub and woodland at the southern edge of Doncaster Racecourse, to the north of the A638 (**Figure 1**).

1.2.2 The Site is largely flat, lying at approximately 10m above Ordnance Datum. Approximately 1.2ha was suitable for geophysical survey.

1.2.3 The near-surface geology underlying the Site comprises glaciolacustrine clays and silts over sandstone bedrock (after BGS 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts suitable for the detection of archaeological remains through magnetometer survey.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed gradiometer survey methodology consisted of detailed magnetometer survey conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was conducted by Wessex Archaeology's in-house geophysics team on 21st March 2012. Field conditions at the time of survey were reasonable, although dense undergrowth and trees reduced the surveyable area.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS system, which is precise to approximately 0.02m and therefore exceeds English Heritage (EH) recommendations (2008).

2.2.2 The magnetometer survey was conducted using Bartington Grad601-2 fluxgate gradiometer instruments, with two sensors deployed vertically 1m apart. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag manner.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all datasets, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying anomalies of probable and possible archaeological interest. Results are presented as a series of greyscale and XY plots (**Figure 2**) at a scale of 1:1250. The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 25nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 3**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 Anomalies **4000** comprise a number of linear and discrete responses adjacent to regions of increased magnetic response and magnetic disturbance. Whilst these anomalies are consistent with pits and short lengths of ditches, their lack of contrast with the general magnetic background, and the extents of magnetic disturbance and noise nearby makes their interpretation uncertain.

3.2.2 Linear and discrete anomalies **4001** lie adjacent to the northern field boundary, in the immediate vicinity of the location of the hoard. The anomalies are relatively weak but, whilst no direct relationship with the hoard can be established, it is possible that these anomalies indicate wider archaeological activity around the hoard findspot.

3.2.3 Discrete anomalies **4002**, towards the western extent of the survey area and south of **4000**, are consistent with pits, although their responses lack contrast with the magnetic background.

3.2.4 Two short linear anomalies **4003**, towards the centre of the survey area, are of possible archaeological interest. Their interpretation is made less certain given the extent of magnetic disturbance in the immediate vicinity.

3.2.5 Linear anomaly **4004** is isolated and only a short length is visible within the dataset. Given that it lies on a similar orientation to **4001**, it is possible that it forms part of an extended group of anomalies.

3.2.6 At the northwestern extent, magnetic disturbance along the edge of the racecourse gives way to increased magnetic response **4005**, although it is unclear whether it is archaeological or modern in origin.

3.2.7 Along the southern boundary, strong magnetic disturbance **4006** associated with Bawtry Road extends a considerable way north into the survey area. It is possible that there is a modern service running along the very southern edge of the dataset, parallel with the road.

3.2.8 Magnetic disturbance **4007** is consistent with the presence of a modern service at the edge of the survey area.

3.2.9 Elsewhere, the dataset shows occasional linear and curvilinear trends, although the origins of these are not clear.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting a number of anomalies of possible archaeological interest within the study area.

4.1.2 There are no anomalies of definite archaeological interest within the survey area, although linear anomaly **4001** and a nearby cluster of pit-like anomalies **4000** lie in close proximity to the hoard findspot. The limited area suitable for geophysical survey and the extent of magnetic disturbance hampers conclusive interpretation of these anomalies.

4.1.3 Elsewhere, the strong responses associated with ferrous debris, the nearby road and possible modern services will have masked weaker responses produced by archaeological features, should any have been present within these areas.

5 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

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

6 APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (English Heritage, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced 0.5m or 0.25m apart, resulting in up to 28800 readings per 30m grid, exceeding English Heritage recommendations (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

7 APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

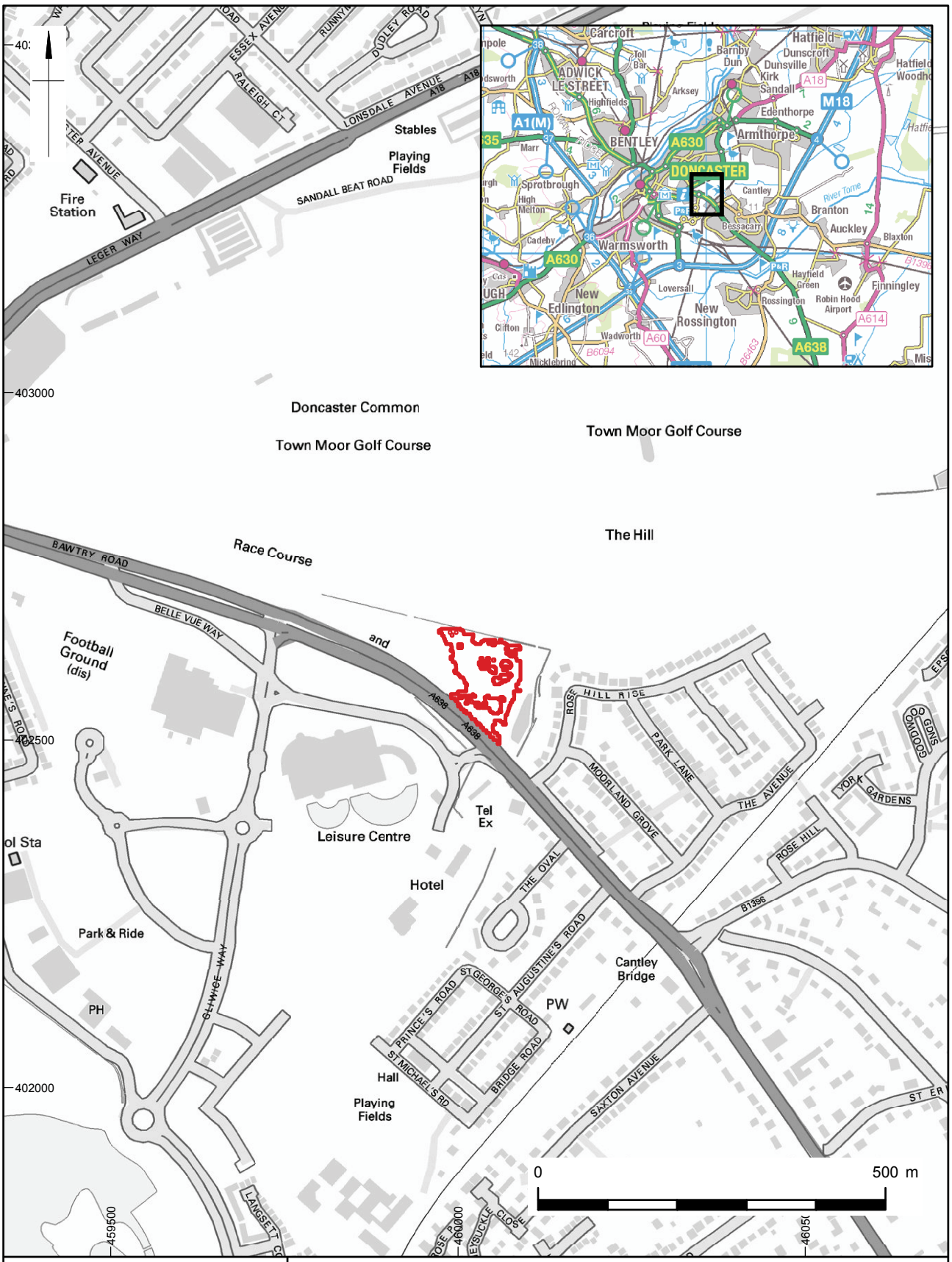
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernable pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



Detail Survey Extents

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Site location plan

Figure 1

Detail Survey Extents

0 50 m

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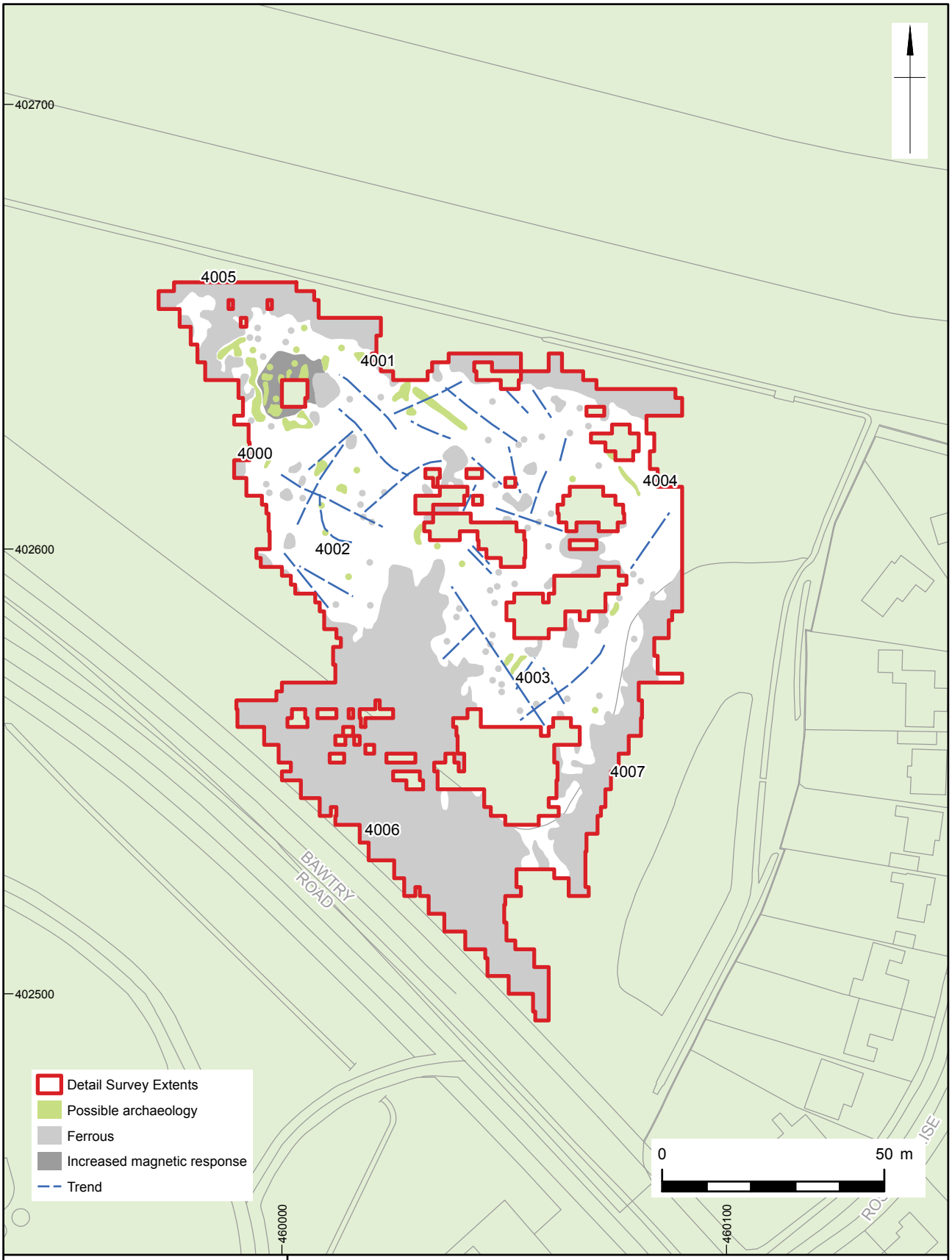
Greyscale and XY Trace

Figure 2



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Interpretation

Figure 3

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