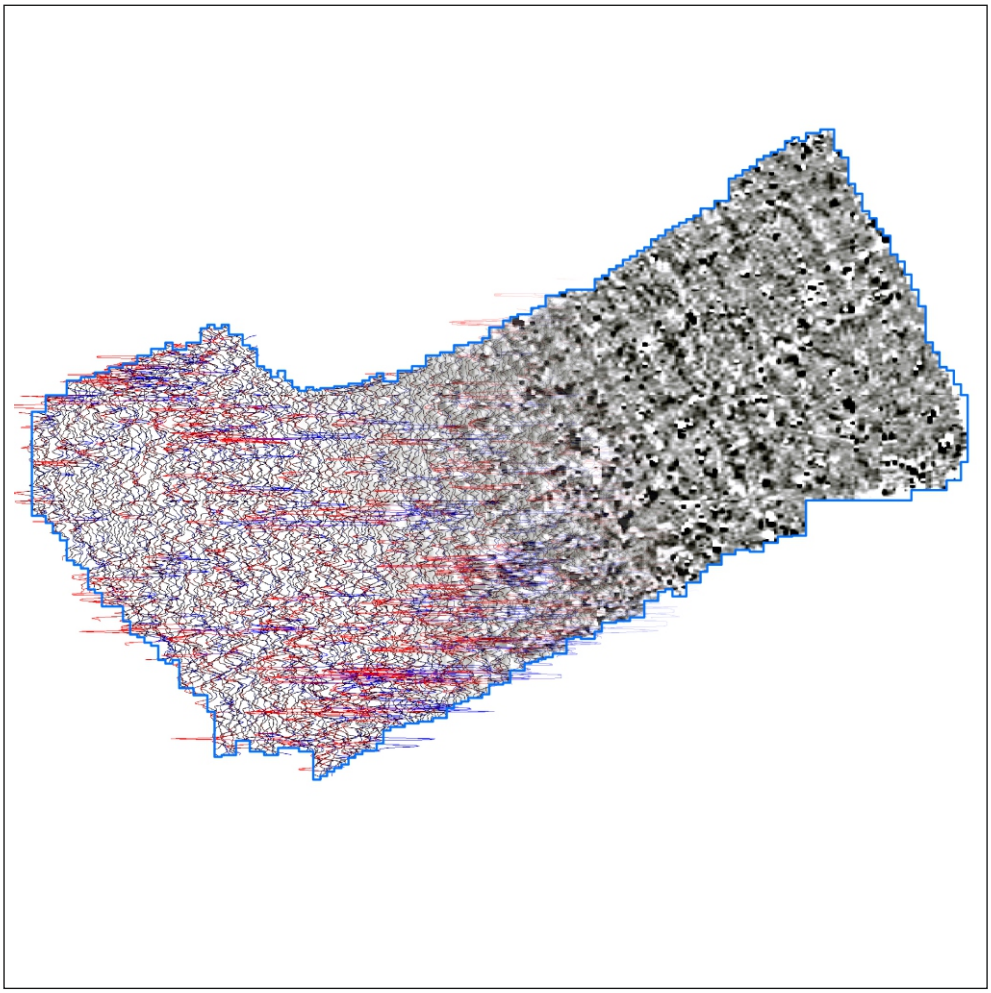
making sense of heritage

Hallgate Lane
Pilsley, Derbyshire

Detailed Gradiometer Survey Report



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July 2015

geoservices

Hallgate Lane
Pilsley, Derbyshire

Detailed Gradiometer Survey Report

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* I= Internal Draft; E= External Draft; F= Final

Hallgate Lane, Pilsley, Chesterfield, Derbyshire

Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land at Hallgate Lane, Pilsley, Derbyshire (centred on NGR 442021, 362790). The project was commissioned by John Church Planning Consultancy Limited with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features in support of a planning application for the residential development of the site.

The site comprises an arable field located to the north of Hallgate Lane where it meets Rupert Street and Bridge Street, covering an area of 3.1ha. The geophysical survey was undertaken on 15th June 2015. The detailed gradiometer survey has demonstrated the presence of a number of anomalies of potential archaeological interest across the survey area.

The most complex area of potential archaeology is located in the west of the survey area. Within this area, numerous discreet linear features have been identified as probable archaeology and consist of ditch-like features of unknown origin and date. These may relate to enclosures and/or former field systems. An area of increased magnetic response in the northwest of the survey area may represent a change in the near surface geology.

The anomalies identified as being of possible archaeological interest are primarily linear ditch-like and pit features also of unknown origin and date.

Additionally, this archaeological investigation has detected numerous ferrous anomalies and evidence for historic cultivation.

Hallgate Lane, Pilsley, Chesterfield, Derbyshire

Detailed Gradiometer Survey Report

Acknowledgements

Wessex Archaeology would like to thank John Church Planning Consultancy Limited for commissioning the geophysical survey.

The fieldwork was undertaken by Phillip Maier and Callum Bruce. Elizabeth Richley and Chris Hirst processed and interpreted the geophysical data and wrote the report. The geophysical work was quality controlled by Garreth Davey and Lucy Learmonth. Illustrations were prepared by Garreth Davey. The project was managed on behalf of Wessex Archaeology by Richard O'Neill.

Hallgate Lane, Pilsley, Chesterfield, Derbyshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by John Church Planning Consultancy Limited to carry out a geophysical survey at land off Hallgate Lane, Pilsley, Chesterfield (hereafter "the Site"), centred on NGR 442021, 362790 (**Figure 1**). The survey forms part of an ongoing programme of archaeological works being undertaken in support of a planning application for a residential development.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

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 Site location and topography

1.2.1 The Site is located on the northern edge of Pilsley and 9km southeast of Chesterfield, in the County of Derbyshire.

1.2.2 The Site occupies an area of 3.1ha of agricultural land, currently utilised for silage. The Site is bounded by Hallgate Lane to the south, Rupert Street to the east and playing fields to the north, with further agricultural land to the west.

1.2.3 The Site is on a gentle south-facing incline from 159m aOD at the southern extent to approximately 167m aOD at the north eastern edge.

1.3 Soils and geology

1.3.1 The solid geology is recorded as comprising of Sandstone from the Pennine Middle Coal Measures Formation with no overlying superficial geological deposits recorded (BGS 2015).

1.3.2 The soils underlying the Site are likely to consist of typical brown earths of the 541f (Rivington 1) association (SSEW SE Sheet 3 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

1.4 Archaeological background

1.4.1 The potential for the survival of buried archaeological remains and details of relevant sites within a 1km Survey area have been summarised below and are included to provide context and inform the geophysical interpretation. This information has been compiled from data provided by the Derbyshire Historic Environment Record (DHER) and the National Heritage List for England (NHLE).

1.4.2 There are no World Heritage Sites, Scheduled Monuments, Registered Parks and Gardens, Conservation Areas or Historic Battlefields identified within the Study Area however there are three Grade II listed buildings recorded.

1.4.3 The three listed buildings consist of 17th century farm buildings and cottages. Morton Road Farmhouse is a circa 17th century farmhouse with attached outbuildings and an associated barn listed separately. (1158007 and 1108910). Sitewell Lane Cottages are a pair of circa 17th Century cottages.

1.4.4 The map regression exercise indicated that the Site area has been in use as arable fields from at least the 19th century to present, however internal boundaries have changed over time.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed gradiometer survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (English Heritage 2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team on 15th June 2015. Field conditions at the time of the survey were good, with dry conditions throughout the period of survey. An overall coverage of 2.5 ha was achieved.

2.2 Method

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

2.2.2 The detailed gradiometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with English Heritage guidelines (2008). Data were collected in the zigzag method.

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 throughout the survey area, 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 detailed gradiometer survey has identified magnetic anomalies across the Site, along with areas of increased magnetic response and a large amount of ferrous. Results are presented as a series of greyscale plots, XY plots and archaeological interpretations at a scale of 1:1500 (**Figures 2** to **4**). 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 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Magnetic anomalies have been identified across the survey area. There are features of possible archaeological nature, along with evidence for historic cultivation and anomalies related to superficial geology.

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

3.1.5 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be present than have been identified through geophysical survey.

3.2 Gradiometer survey results and interpretation

3.2.1 A weak linear feature **4000,** aligned southwest-northeast is evident and has been interpreted as being probable archaeology. The magnetic response is consistent with those of a cut ditch feature. The linear anomaly is approximately 2m wide and 45m long however it is fragmented. This maybe a boundary feature damaged by farming activity on site.

3.2.2 A broken linear feature of similar magnetic properties has been identified at **4001.** The feature is made up of three parts aligned northwest-southeast, approximately 1-3 meters wide and totalling a length of 141m across the entire Site. This is also likely to be a boundary feature and is possibly related to **4000,** which it meets at a perpendicular point. These may form boundaries of a field system or other form of land division.

3.2.3 A pair of parallel linear positive magnetic anomalies at **4002** are aligned northeast southwest and are approximately 2.5m wide and 17-18m long. Given their proximity to the edge of the survey it is difficult to interpret the origin of these features, however, they are clear magnetic responses and have been interpreted as probable archaeology.

3.2.4 A long weak +1nT linear anomaly has been identified across the middle of the site at **4003** and **4004.** This feature is aligned southwest-northeast and runs the length of the site, approximately 234 meters, and is likely to continue outside of the survey area. The width of the feature varies between approximately 6-8 meters. This is likely a form of land division although this is unclear given the weakness of the magnetic response of this feature. Its relation to linear features at **4002** is also unknown.

3.2.5 A short linear feature has been identified at **4005**. This is only 10m x 2m however it does respect the alignment of **4000** and also meets **4001** and therefore maybe a further division in the possible field system.

3.2.6 Several pit like features have been identified at **4006.** These have been interpreted as of possible archaeological provenance however these could also be geological anomalies, as they do not have any specific spatial patterning to the distribution. There are also similar pit like features elsewhere across the site.

3.2.7 The linear feature **4007** aligned southwest-northeast is approximately 6-8 meters in width and approximately 73 meters in length with magnetic responses similar to those observed at **4004.** This feature is situated north of **4004** and in the same alignment but it is not possible to say if they are related.

3.2.8 There are also weakly magnetised trends identified throughout the survey area but due to their weakness, their origin is unknown. Areas of agricultural cultivation and ploughing trends have also been highlighted in the dataset.

3.3 Modern Services

3.3.1 There were no modern services detected within the survey area.

3.3.2 It should also be noted that gradiometer survey may not detect all services present on Site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on Site.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of archaeological interest across the Site. In addition to these, anomalies interpreted as ploughing trends and areas of increased magnetic response have been identified.

4.1.2 The most complex area of potential archaeology is located to the west of the field **4000**, **4001**, **4005**. Within this area numerous discreet linear features have been identified with archaeological potential and consist of likely ditch-like features of unknown origin and date. These appear to form a system likely related to land division.

4.1.3 A linear anomaly has been identified at **4004** of unknown provenance but similar to the feature at **4007**. These have no clear relationship beside their alignment and magnetic properties however.

4.1.4 Frequent ploughing trends are visible across the Site mainly on northwest-southeast alignment and are likely to be medieval, post-medieval or modern in provenance.

5 REFERENCES

5.1 Bibliography

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

5.2 Cartographic and documentary sources

Ordnance Survey

1878 Derbyshire 25” (1:2500)

1884 Derbyshire 6” (1:10,560)

1899 Derbyshire 25” (1:2500)

1900 Derbyshire 6” (1:10,560)

1917-18 Derbyshire 25” (1:2500)

1921 Derbyshire 6” (1:10,560)

1937-39 Derbyshire 25” (1:2500)

1939 Derbyshire 6” (1:10,560)

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

5.3 Online resources

UK Soil Observatory, http://www.ukso.org [accessed June 2015]

British Geological Survey, http://www.bgs.ac.uk [accessed June 2015]

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 (EH, 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 up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (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.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into four main categories: archaeological, modern, agricultural and uncertain origin/geological.

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 discernible pattern or trend.

The modern category is used for anomalies that are presumed to be relatively modern in date:

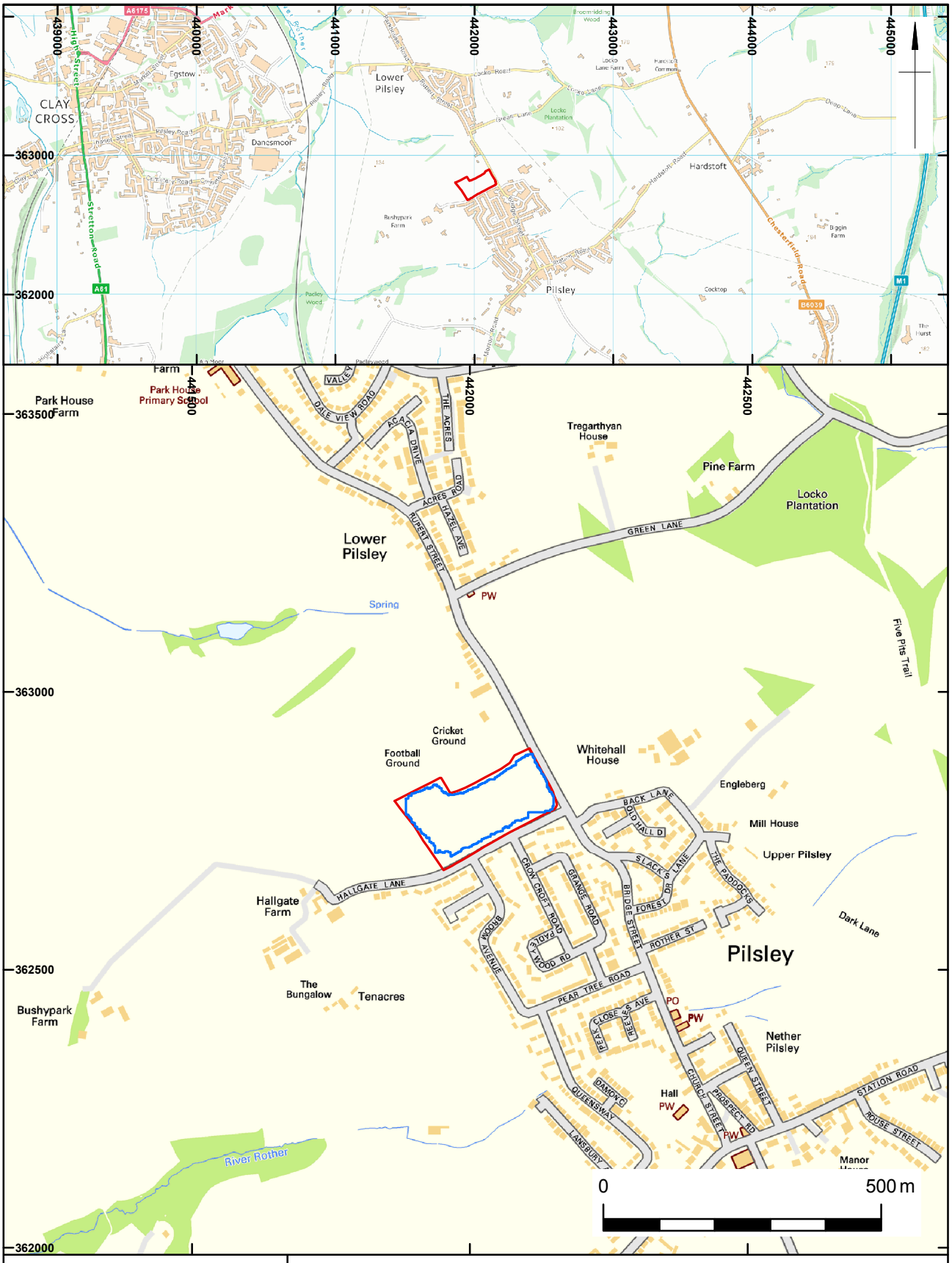
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Agricultural ditches – used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological 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.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Detailed Survey Extents

Survey Boundary

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Site location and survey extents

Figure 1

Detailed Survey Extents

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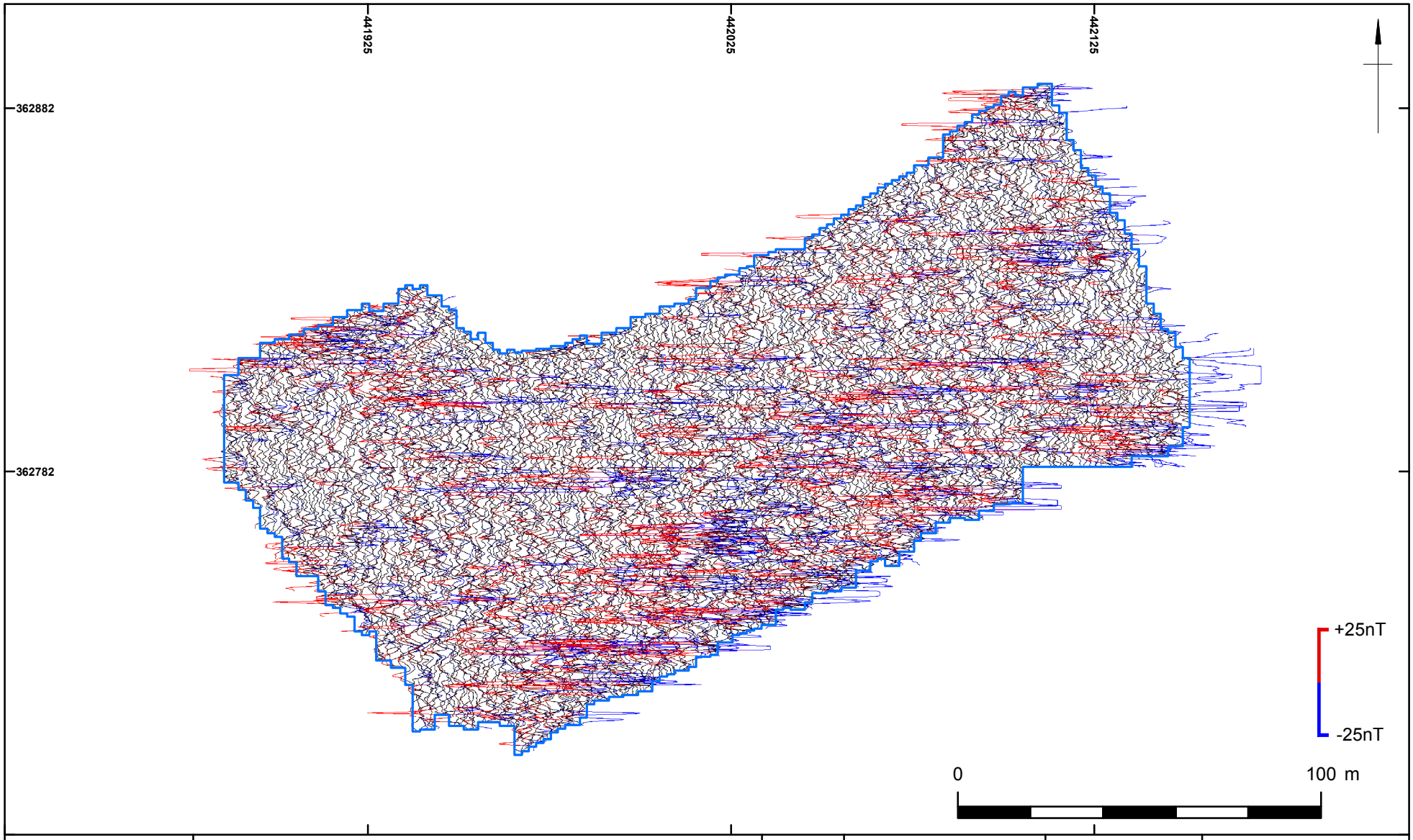
Greyscale plot

Figure 2



Detailed Survey Extents

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XY Trace plot

Figure 3

Date:	02/07/2015	Revision Number:	0
Scale:	1:1500 at A4	Illustrator:	GJD
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Archaeological Interpretation

Figure 4

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