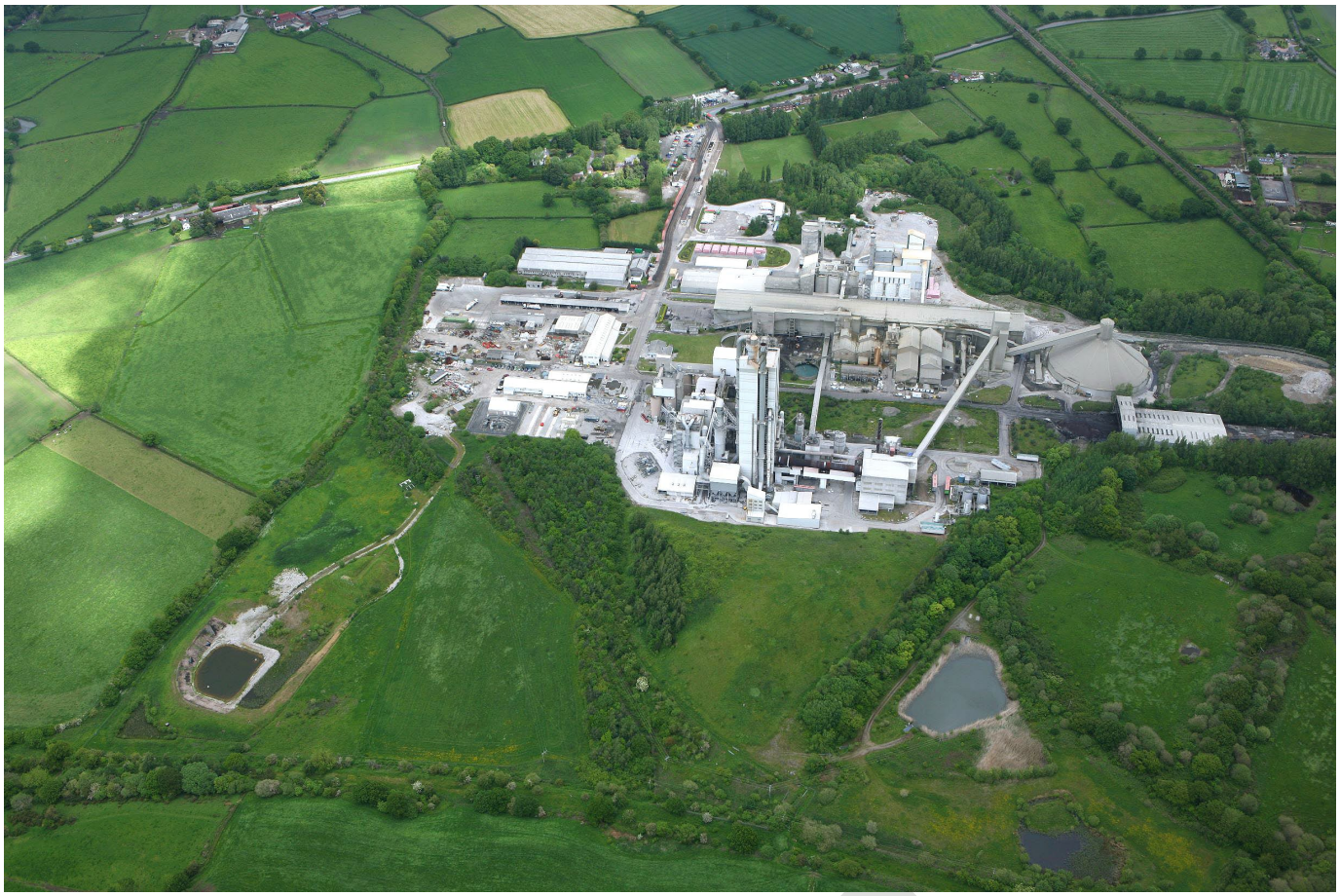

Castle Cement Limited

Carbon Capture and Storage Project – Padeswood, North Wales

Volume 4, Draft Technical Appendix 8.2

Geophysical Survey Report

RSK

JUNE 2024

CONTENTS

LIST OF ILLUSTRATIONS

APPENDICES

1 INTRODUCTION

1.1.1 Headland Archaeology Limited (an RSK Group company) was commissioned by Castle Cement Limited (the Applicant) to undertake a geophysical (magnetometer) survey on land surrounding Padeswood Cement Works, to the south-east of Buckley, Flintshire (Illus 1), where the Applicant intends to submit a planning application for a proposed carbon capture and storage facility. This geophysical survey report will be submitted as part of the planning application for the Proposed Development. The results may also inform future archaeological strategy, if required.

1.1.2 The scheme of work was undertaken in accordance with the requirements of the National Planning Policy Framework (DLUHC 2023) and with the Written Scheme of Investigation for Geophysical Survey (WSI) (Headland Archaeology 2023).

1.1.3 The survey was undertaken in accordance with the requirements of Planning Policy Wales 2023 (Edition 12, Ch.6 The Historic Environment) and guidance set out by the Guidance for the Submission of Data to the Welsh Historic Environments Records 2022.

1.1.4 The WSI was produced to the standards laid down in the European Archaeological Council's guideline publication, EAC Guidelines for the Use of Geophysics in Archaeology (Europae Archaeologia Consilium 2016) and the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for Archaeological Geophysical Survey (CifA 2020a). The survey was also carried out in line with the same best practice guidelines.

1.1.5 The survey was carried out between 06 November and 08 November 2023.

1.2 Site Location, Topography and Land-use

1.2.1 The Site is located approximately 1km to the south east of Buckley, approximately 0.5km west of Penyffordd, and covers an area of approximately 70.9ha. However, much of this area is covered by Padeswood Cement Works and associated infrastructure, tracks, and woodland. The actual area suitable for geophysical survey (the geophysical survey area - GSA) covered 20.3ha split between three irregularly shaped parcels of land (sectors) across fourteen fields (F1 to F14); Sector 1 (F1 to F4) to the north west of the cement works, Sector 2 (F5 to 13) to the north east and Sector 3 (F13 and F14) to the south west. The GSA excluded areas earmarked for habitat creation rather than groundworks, but areas of tree planting were included within the survey area.

1.2.2 Sector 1 is centred at SJ 28820 62485, Sector 2 at SJ 29407 62495, and Sector 3 at SJ 28857 62022.

1.2.3 The three sectors are bound by roads, extant and disused railway lines, and pasture fields. Sector 1 is bound by the A5118 to the north and pasture fields to the west. Sector 2 is bound by the A5118 to the north and a railway line to the east and Sector

3 is bound by a railway to the east, a disused railway to the south, pasture fields to the west and woodland to the east.

1.2.4 All the fields where survey was possible were under permanent pasture (Illus 2 and Illus 3) but there were several unsuitable areas which were either completely overgrown or comprised areas of hardstanding (Illus 4 and Illus 5).

1.2.5 Topographically the land within the GSA lies on a flat plain approximately 110m above Ordnance Datum (AOD).

1.3 Geology and Soils

1.3.1 The bedrock beneath Sector 1 comprises Pennine Middle and Lower Coal Measures Formation (CMF), a sedimentary bedrock consisting of mudstone, siltstone, and sandstone, formed between 319 and 309.5 million years ago during the Carboniferous period. Pennine Lower CMF also underlies Sector 2. In Sector 3 Gwespyr Sandstone is recorded, a sedimentary bedrock consisting of sandstone and argillaceous rocks, formed between 320 and 318 million years ago also during the Carboniferous period.

1.3.2 Superficial deposits of Till, Devensian – Diamicton, a sedimentary superficial deposit formed between 11.6 and 11.8 thousand years ago during the Quaternary Period, overlie the bedrock in all three sectors apart from along the southern fringes of Sector 3 where there is a small band of Head - clay, silt and gravel formed between 2.588 million years ago and the present during the Quaternary period (UKRA 2023).

1.3.3 The soils across the GSA are described as slowly permeable seasonally wet acid loamy and clayey soils, as classified in the Soilscape 17 Association (Cranfield University 2023).

2 ARCHAEOLOGICAL BACKGROUND

2.1.1 The following background is summarised from an Archaeological Desk-Based Assessment (ADBA - Headland Archaeology 2023) and the principal assets shown on Illus 6.

2.1.2 There is no evidence of prehistoric activity within the Site boundary with limited evidence of prehistoric activity in close proximity. Padeswood Pool mound (PRN100091), located 1km west of the Site is a non-designated former mound that may have comprised a tumulus with a barrow on top.

2.1.3 There is no evidence of Roman activity within the Site itself and only limited evidence in the immediate environs. Cold Harbour Field, located 1km north of the Site, is a three-sided area defined by roads and an agricultural boundary thought to have Roman origins.

2.1.4 There is limited evidence of Saxon or early medieval activity within or surrounding the Site. Within the field immediately bordering Sector 3 is Wat's Dyke (FLO88/FLO89), a linear earthwork most likely designed as a continuous construction by the Anglo-Saxon kingdom of Mercia.

2.1.5 Less than 0.5km west of the Site is a single non-designated asset, Bryn-Celyn (PRN64011), an early medieval linear earthwork with a post-medieval house.

2.1.6 The only evidence of medieval activity within the Site is a single historic asset comprising an area of ridge and furrow (PRN98858) 200m south east of Sector 3. Four other fields containing ridge and furrow are recorded, three immediately south of the Site (PRN98857, PRN98861, and PRN98912) and PRN99098, approximately 0.5km due east of Sector 2.

2.1.7 The ADBA concluded that there was a high potential for previously unknown medieval remains within the Site.

2.1.8 Within the Site (but not in the GSA) itself there are five known historic assets:

- Padeswood Hall and Padeswood Hall gardens (PRN409419/PRN266274) which date to the mid-19th century;
- Padeswood Hall Farm; and
- Bannel Farm coal shafts (PRN98339) and The Works coal shafts (PRN98338) which are depicted on historic OS mapping, both bordering Sector 2.

2.1.9 Within 1km of the Site there is an assortment of post-medieval farm buildings, coal pits, toll houses, kilns, and pump houses.

3 AIMS, METHODOLOGY & PRESENTATION

3.1 Aims and Objectives

3.1.1 The principal aim of the geophysical survey was to gather information to establish the presence/absence, character, and extent of any archaeological remains within the Site. This will enable an assessment to be made of the impact of the Proposed Development on any sub-surface archaeological remains if present, and thereby inform any further investigation strategies, as appropriate.

3.1.2 The specific archaeological objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the likely presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

3.2 Methodology

3.2.1 Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations detailed plans of sites can be obtained, as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in **Appendix 1**.

3.2.2 Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths, and areas of burning, and kilns and brick structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures, and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves/burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive evaluation tool for this site.

3.2.3 The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The

system was linked to a Leica GS18 T GNSS RTK Rover outputting in NMEA mode to ensure a high positional accuracy of each data point; +/- 1cm for each reading.

3.2.4 MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Anomaly GeoSurvey v1.12.3 (Lichenstone Geoscience) and QGIS v.3.28.5 software was used to process and present the data respectively.

3.3 Data Presentation and Technical Detail

3.3.1 A general site location plan is shown in Illus 1 at a scale of 1:15,000. Illus 2 to Illus 5 inclusive are site condition photographs. Illus 6 shows the GPS swaths, and the location and direction of the site condition photographs as well as known heritage assets within or adjacent to the Site, at 1:8,000. Illus 7 and Illus 8 show overviews of the processed magnetometer data and interpretation respectively, also at a scale of 1:8,000. Fully processed (greyscale) data, minimally processed data (XY trace plot) data and interpretative plans are presented by Sector, at 1:2,500, in Illus 9 to Illus 17 inclusive.

3.3.2 Technical information on the equipment used, data processing and magnetic survey methodology is given in **Appendix 1**. **Appendix 2** details the survey location information and **Appendix 3** describes the composition and location of the Site archive. Data processing details are presented in **Appendix 4**.

3.3.3 The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Headland Archaeology 2023), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2020a). All illustrations from Ordnance Survey (OS) mapping are reproduced with the permission of the controller of His Majesty's Stationery Office (© Crown copyright).

3.3.4 The Illustrations in this report have been produced following analysis of the data in 'raw' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of Headland Archaeology management and reporting staff.

4 RESULTS & DISCUSSION

4.1 Site Conditions

4.1.1 Magnetometer survey is generally recommended over any sedimentary bedrock but the 'average response' on Pennine Lower Coal Measures Formation and on Gwespyr Sandstone is variable and can be poor (English Heritage 2008; Table 4). Nevertheless, magnetometry was still the most appropriate non-intrusive geophysical technique for evaluating the Site, taking account of the limitations noted in **Section 3.2** and above.

4.1.2 Where survey was carried out the surface conditions were generally average (Illus 2 and Illus 3), being predominantly laid to pasture, although the fields in Sector 3 were extremely wet. Several areas were unsuitable for survey being either overgrown or covered by hardstanding (Illus 4 and Illus 5). No other problems were encountered during the fieldwork.

4.1.3 The magnetic background was generally homogenous with no significant difference between the data recorded on differing bedrock and superficial geologies. Data quality was good although there was a lot of ferrous contamination due to the industrial nature of much of the Site.

4.1.4 Against this magnetic background, anomalies of various origin have been recorded (Illus 7). The fact that anomalies were recorded confirms that there was sufficient magnetic contrast, for the detection of potentially archaeological features, notwithstanding the limitations of magnetometer survey to identify the types, sizes, and period of archaeological features as described in **Section 3.2** and keeping in mind the generally average to poor response to magnetometer survey on Pennine Lower Coal Measures Formation, the prevailing geology. The results of the survey therefore likely provide a reasonably good indication of the extent of sub-surface archaeological features within the three geophysical survey areas.

4.1.5 The anomalies are discussed below according to their interpreted origin.

4.2 Ferrous and Modern Anomalies

4.2.1 Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being introduced into the topsoil during manuring or tipping/infilling.

4.2.2 Given the location of the survey areas in and around the periphery of an industrial complex it is not surprising that the data set is dominated in places by responses and anomalies related to the current and modern usage of the Site. Hence there are numerous linear dipolar anomalies indicative of sub-surface pipes and services particularly in Sector 1 and Sector 2 (Illus 8 – SP1 to SP11). Bands or small areas of magnetic disturbance recorded along the field edges, particularly in Sector 1, are likely to be due to the adjacent roads, tracks and the railways that bound Sector 2

and Sector 3 and to the proximity of the cement works and its associated infrastructure and former mining.

4.2.3 None of the areas of disturbance are interpreted as having any archaeological potential.

4.3 Agricultural Anomalies

4.3.1 The clay nature of the prevailing soils is attested by the ubiquitous presence of linear anomalies caused by field drains across all the fields within the GSA.

4.3.2 In Sector 2, particularly in F9 to F13 inclusive, widely spaced linear anomalies indicative of ridge and furrow cultivation are recorded.

4.3.3 Other straighter, more closely spaced linear trends, such as those in Sector 3 (F14), are more likely indicative of more recent cultivation.

4.4 Anomalies of Geological Origin

4.4.1 In the south-eastern section of F14, weakly magnetic, curvilinear, and amorphous anomalies are interpreted as likely geological in origin. These anomalies correlate with the mapped location of the superficial deposits of Head (clay, silt, sand, and gravel) recorded here, and are caused by the change in composition and depth of the geologies present.

4.5 Anomalies of Uncertain Origin

4.5.1 No anomalies have been interpreted as uncertain.

4.6 Anomalies of Possible or Probable Archaeological Origin

4.6.1 No anomalies of likely archaeological origin have been recorded.

5 CONCLUSION

5.1.1 No anomalies of likely archaeological potential have been recorded by the survey. The majority of the anomalies identified are of agricultural or modern origin, specifically anomalies locating field drains and indicative of ridge and furrow and more recent cultivation, service pipe and cables.

5.1.2 The fragmentary nature and irregular shape of the survey areas together with the effects of the proximity of a major industrial complex and associated infrastructure has meant that a confident assessment of the archaeological potential of the Site is not straightforward. The levels of magnetic disturbance in localised areas within the Site mean that the much lower magnitude response from a sub-surface archaeological feature, if present, may be masked. However, the lack of any anomalies of likely archaeological potential combined with the paucity of previously known assets (excepting evidence of post-medieval mining and ridge and furrow cultivation) suggests that the archaeological potential of the areas covered by the survey is low.

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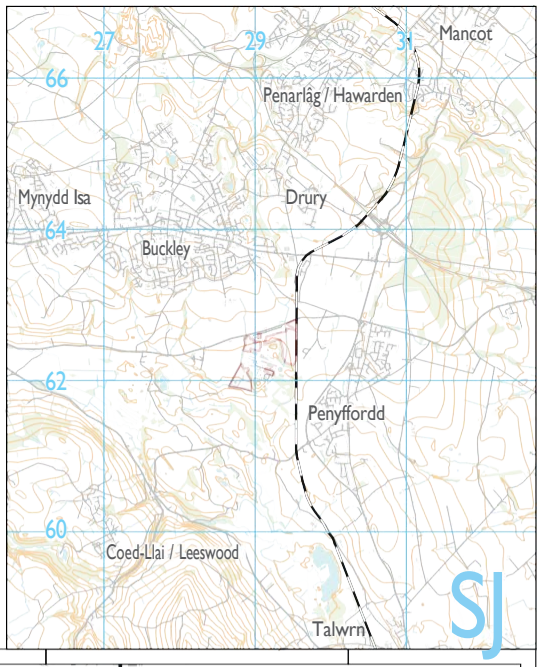
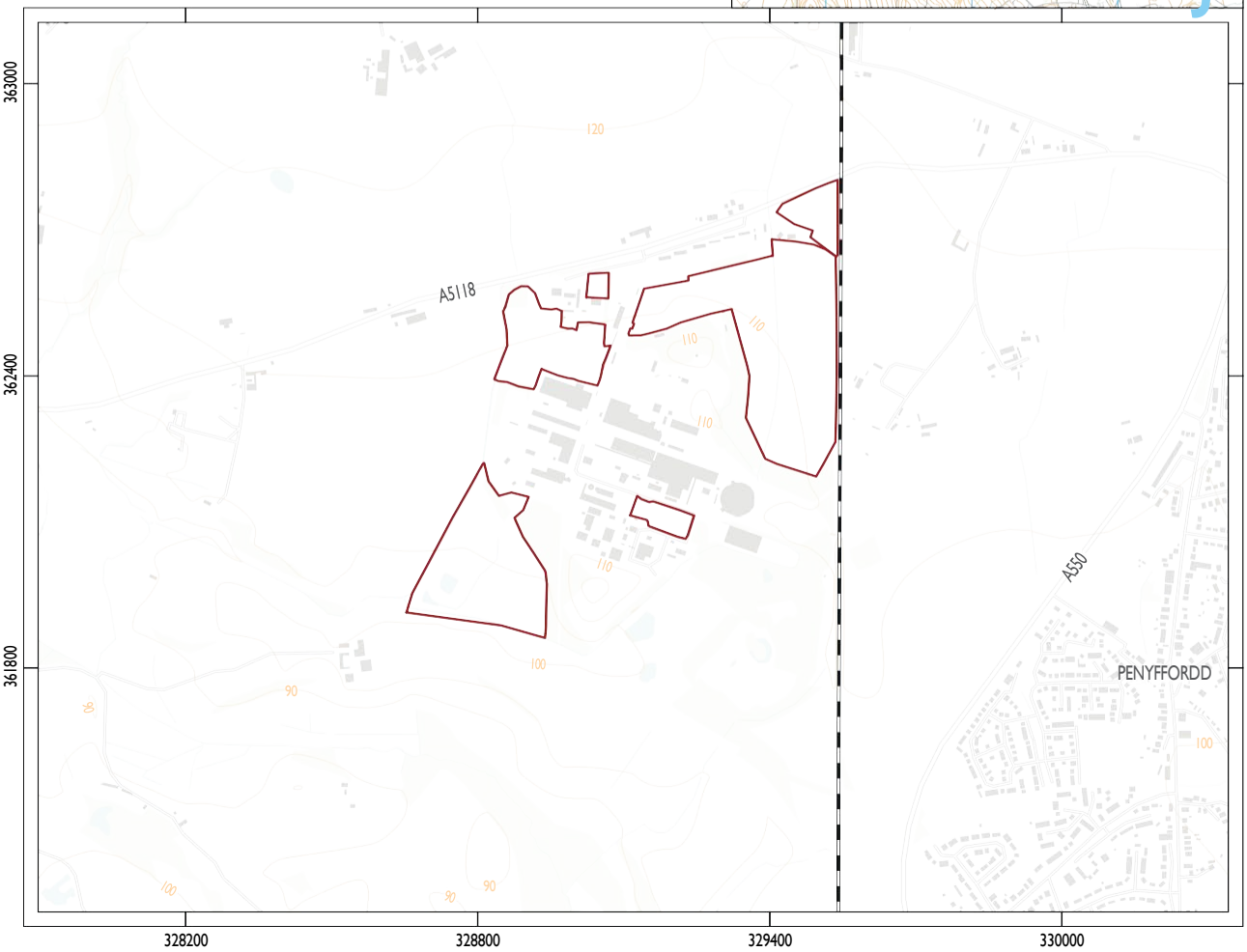
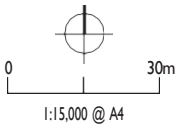
LIST OF ILLUSTRATIONS

ILLUS 1 SITE LOCATION (1:15,000)

Padeswood Carbon Capture Project
Flintshire
Wales







geophysical survey area

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t 0127 493 8019
e yorkshireandnorth@headlandarchaeology.com
w www.headlandarchaeology.com

ILLUS 1 Site location

ILLUS 2 F1, LOOKING NORTH EAST

ILLUS 2 F1, looking north-east

ILLUS 3 F14, LOOKING SOUTH EAST

ILLUS 3 F14, looking south-east

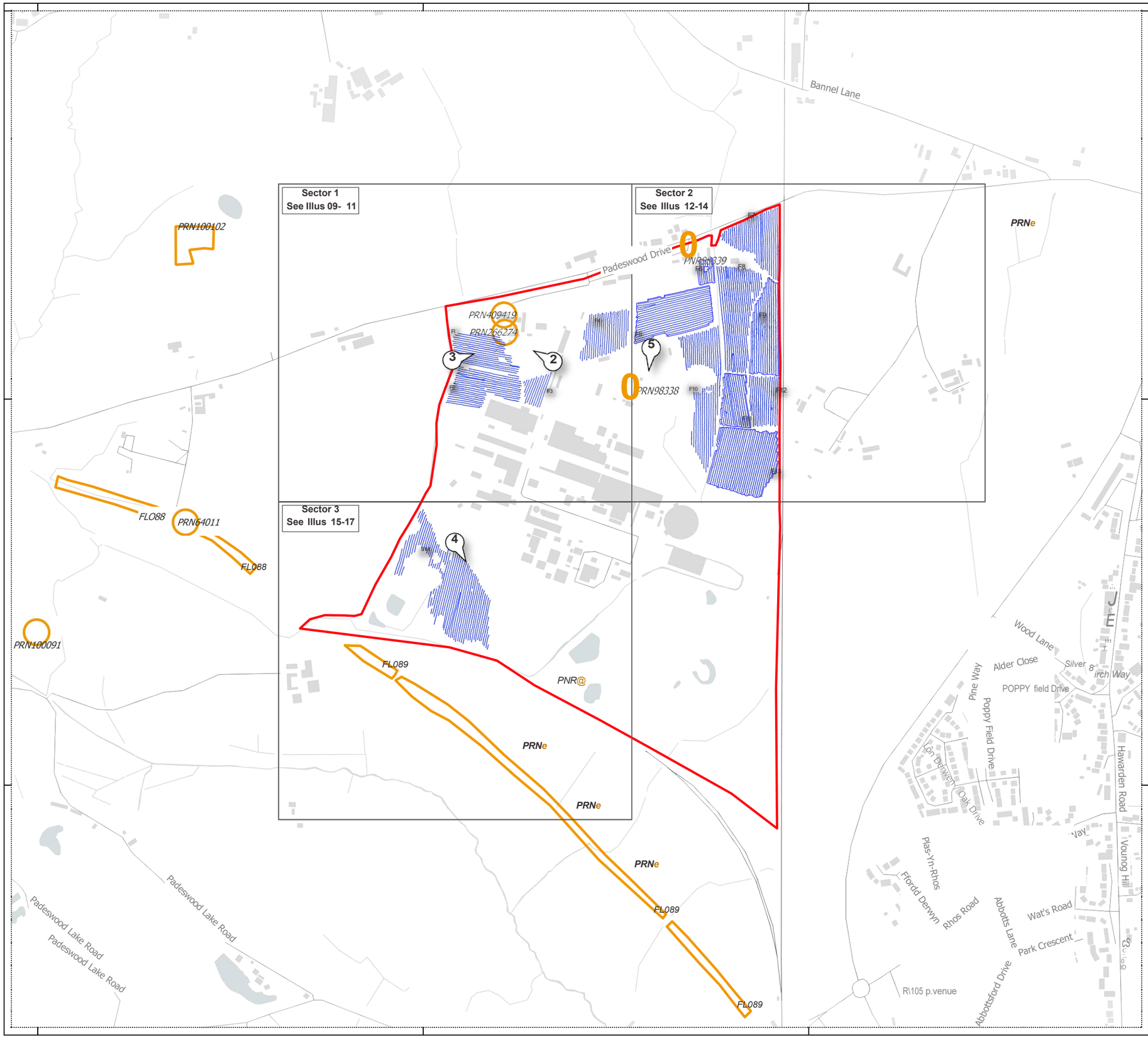
ILLUS 4 UNSUITABLE AREA IN NORTHWESTERN PARCEL, LOOKING NORTH-WEST

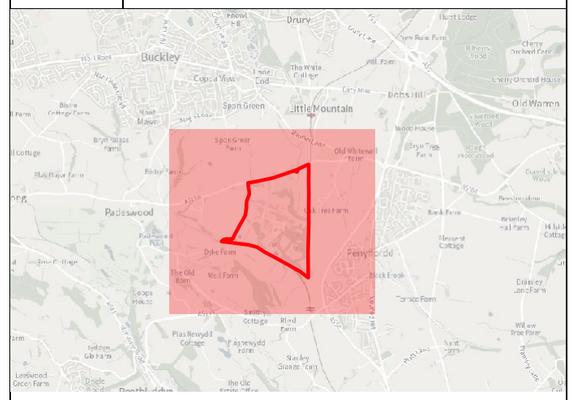
ILLUS 4 Unsuitable area in northwestern parcel, looking north-west

ILLUS 5 UNSUITABLE AREA IN NORTHEASTERN PARCEL, LOOKING SOUTH

ILLUS 5 Unsuitable area in northeastern parcel, looking south

ILLUS 6 SURVEY LOCATION SHOWING GPS SWATHS AND PHOTOGRAPH LOCATIONS (1:8,000)





Key

- Site Boundary
- Location and Direction of Illus 02-05
- Survey Extent
- GPS Swaths
- Area for Illus 9-17
- Historic Environment Record Asset

0 200 400m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:8,000 @A3

Illus 06 - Survey location showing GPS swaths and photograph locations

ILLUS 7 OVERALL GREYSCALE PLOT OF PROCESSED MAGNETOMETER DATA (1:8,000)

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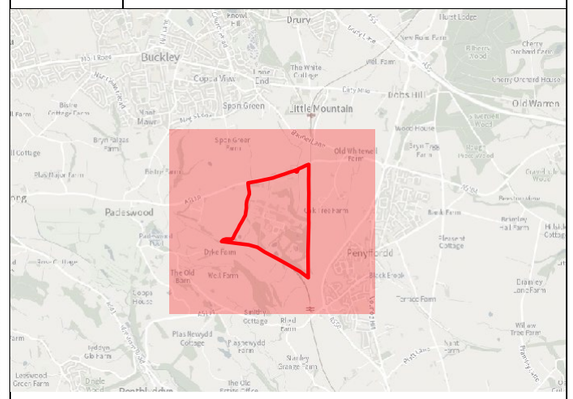


Key

D Site Boundary

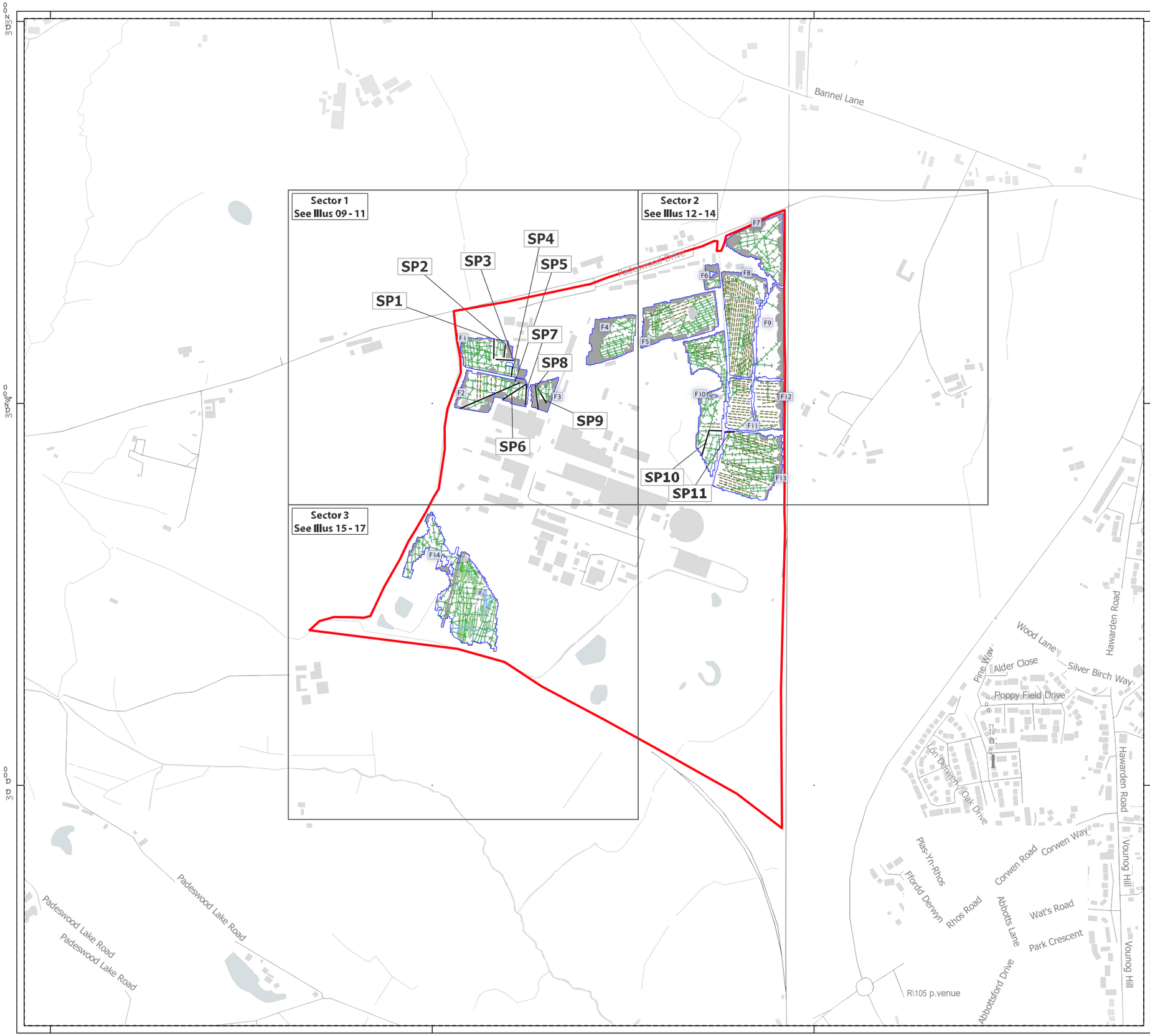
Survey Extent

D Area for Illus 9-17

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:8,000 @A3

Illus 07 - Overall greyscale plot of processed magnetometer data

ILLUS 8 OVERALL INTERPRETATION OF MAGNETOMETER DATA (1:8,000)



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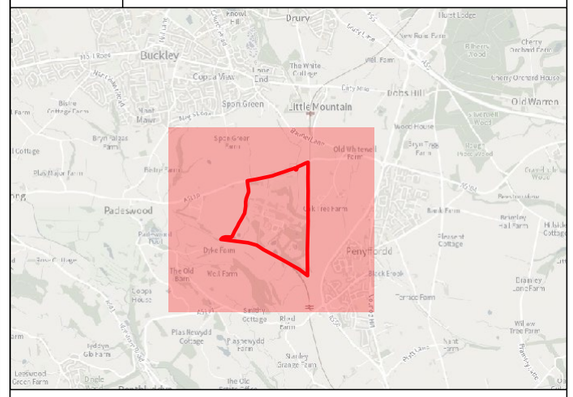

Key

- D Site Boundary
- Survey Extent
- D Area for Illus 9-17
- Ferrous Objects
- Agriculture
- Field Drain
- Natural
- Service
- Ridge and Furrow
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)

Abbreviations

SP Service Pipe

0 200 400m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:8,000 @A3

Illus 08- Overall interpretation of magnetometer data

ILLUS 9 PROCESSED GREYSCALE MAGNETOMETER DATA; SECTOR 1 (1:2,500)

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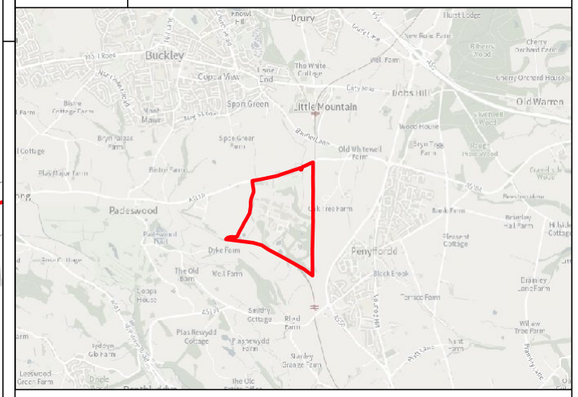

Key

D Site Boundary

Survey Extent

+2nT

-lnT

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 09 Processed greyscale magnetometer data; Sector 1

ILLUS 10 XY TRACE PLOT OF MINIMALLY PROCESSED MAGNETOMETER DATA; SECTOR 1 (1:2,500)

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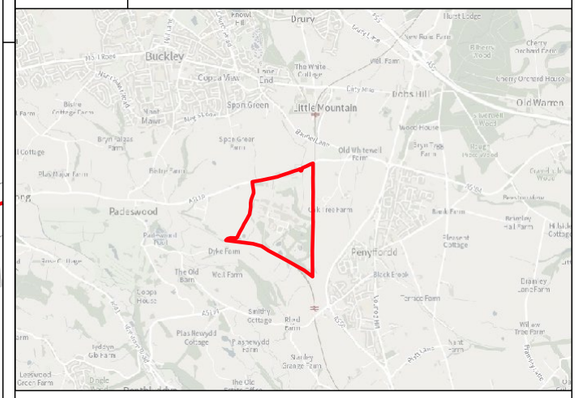


Key

D Site Boundary

Survey Extent

XY trace (25nT/cm)

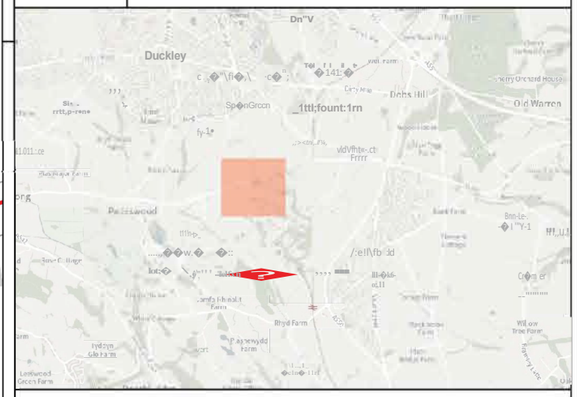
0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 10 XV trace plot of minimally processed magnetometer data; Sector 1

ILLUS 11 INTERPRETATION OF MAGNETOMETER DATA; SECTOR 1 (1:2,500)

tBHEADLAND ARCHAEOLOGY
part of the lc'l(Group



Key

- Site Boundary
- Survey Extent
- Ferrous Objects
- Field Drain
- Service
- Ridge and Furrow
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)

Abbreviations

SP | Service Pipe

0 60 120m

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Checked by:	PT
Version:	v1.0
Date:	27/05/2024
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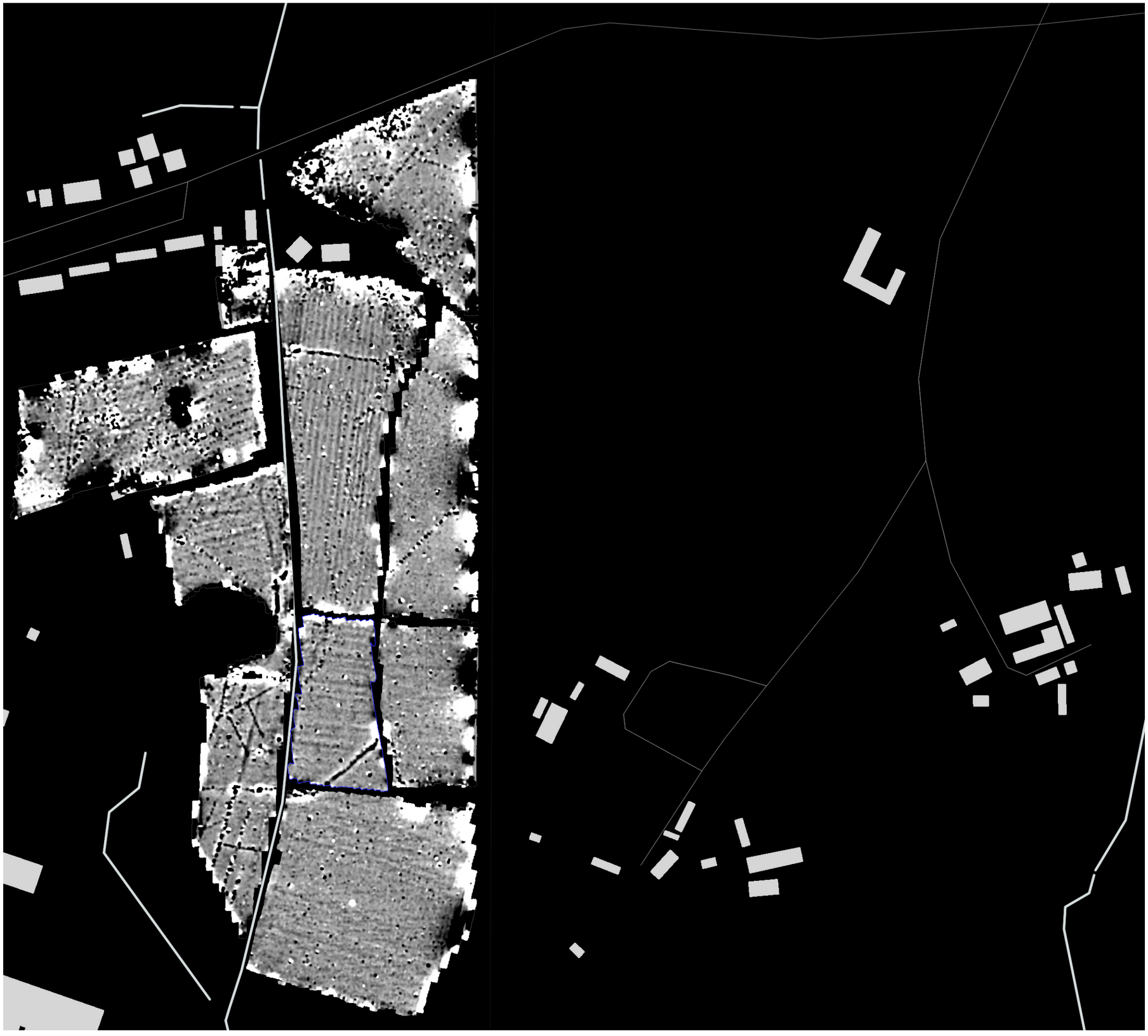
328500 328750 329000

Illus - 11 Interpretation of magnetometer data; Sector 1

ILLUS 12 PROCESSED GREYSCALE MAGNETOMETER DATA; SECTOR 2 (1:2,500)



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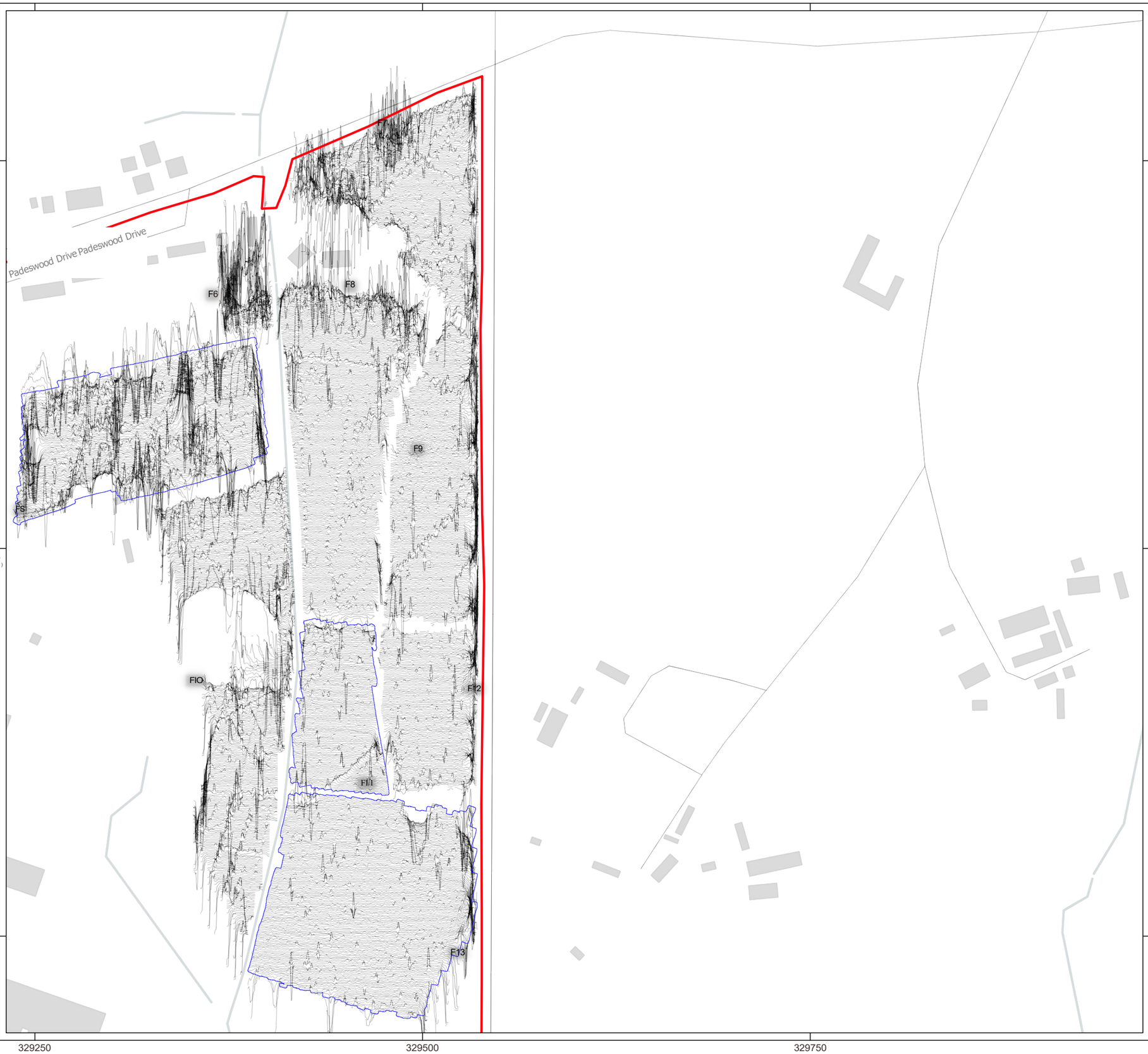
Key

Site Boundary

Survey Extent

ILLUS 13 XY TRACE PLOT MINIMALLY PROCESSED MAGNETOMETER DATA; SECTOR 2 (1:2,500)



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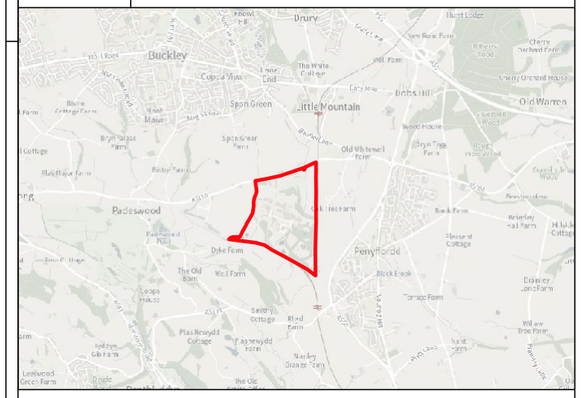

Key

D Site Boundary

Survey Extent

XY trace (25nT/cm)

0 60 120m

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Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 13 XV trace plot of minimally processed magnetometer data; Sector 2

ILLUS 14 INTERPRETATION OF MAGNETOMETER DATA; SECTOR 2 (1:2,500)

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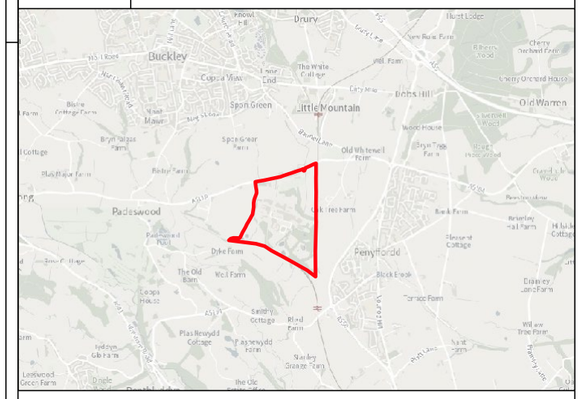
HEADLAND ARCHAEOLOGY
part of the RSK Group



Key

- Site Boundary
- Survey Extent
- Ferrous Objects
- Field Drain
- Service
- Ridge and Furrow
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)

Abbreviations

SP Service Pipe

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 14 Interpretation of magnetometer data; Sector 2

ILLUS 15 PROCESSED GREYSCALE MAGNETOMETER DATA; SECTOR 3 (1:2,500)

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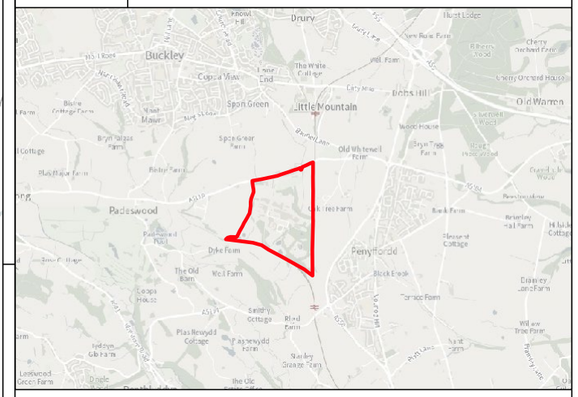

Key

D Site Boundary

Survey Extent

+2nT

-lnT

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 15 Processed greyscale magnetometer data; Sector 3

HEADLAND ARCHAEOLOGY
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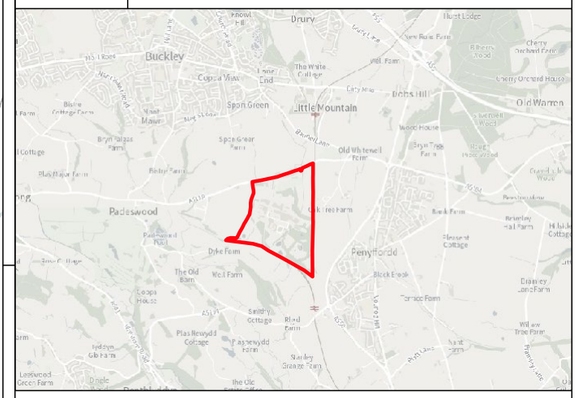


Key

D Site Boundary

Survey Extent

+2nT

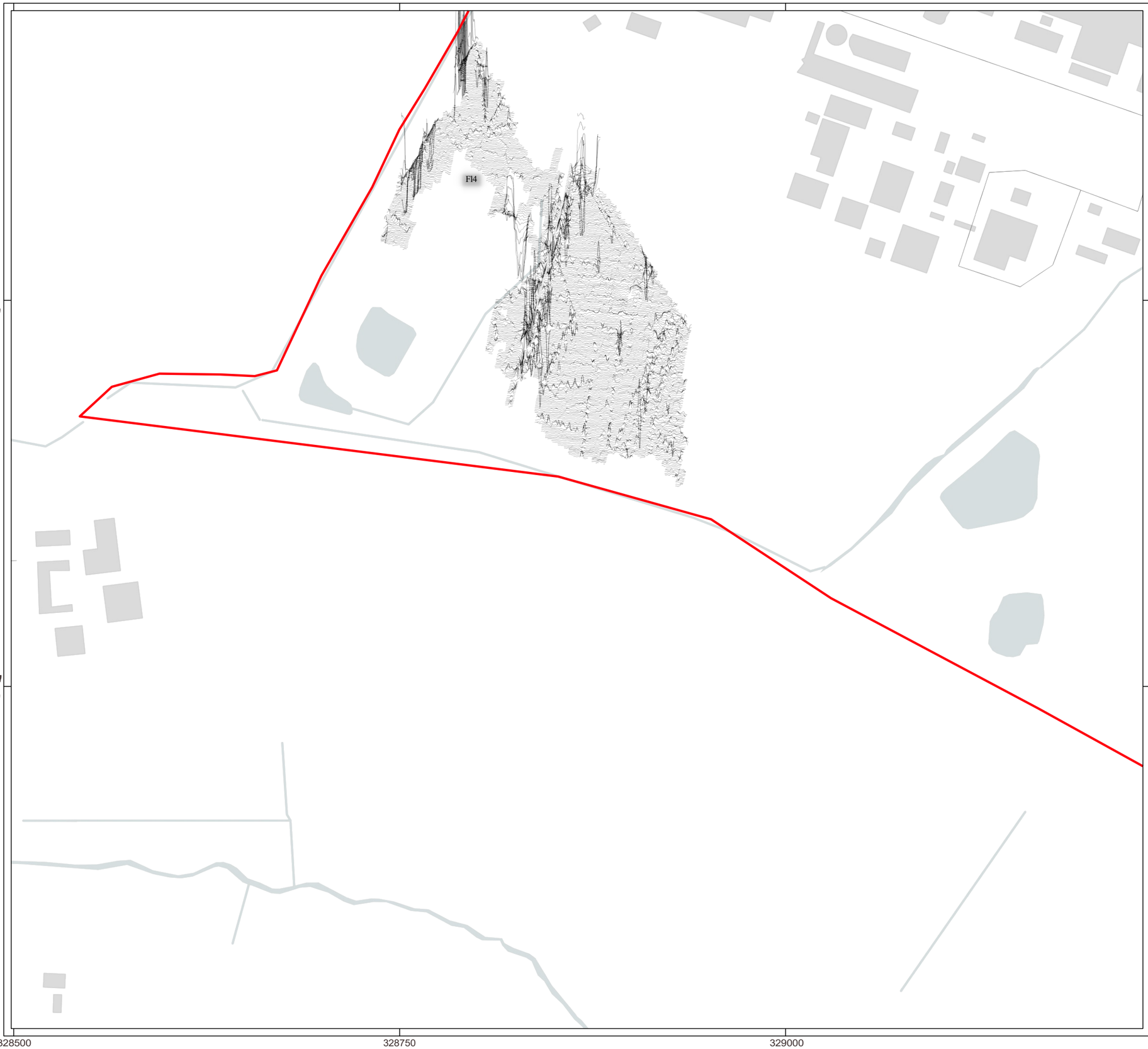
-lnT

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 15 Processed greyscale magnetometer data; Sector 3

ILLUS 16 XY TRACE PLOT OF MINIMALLY PROCESSED MAGNETOMETER DATA; SECTOR 3 (1:2,500)



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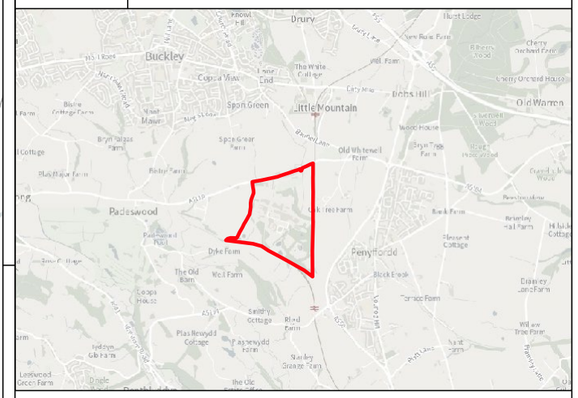


Key

D Site Boundary

Survey Extent

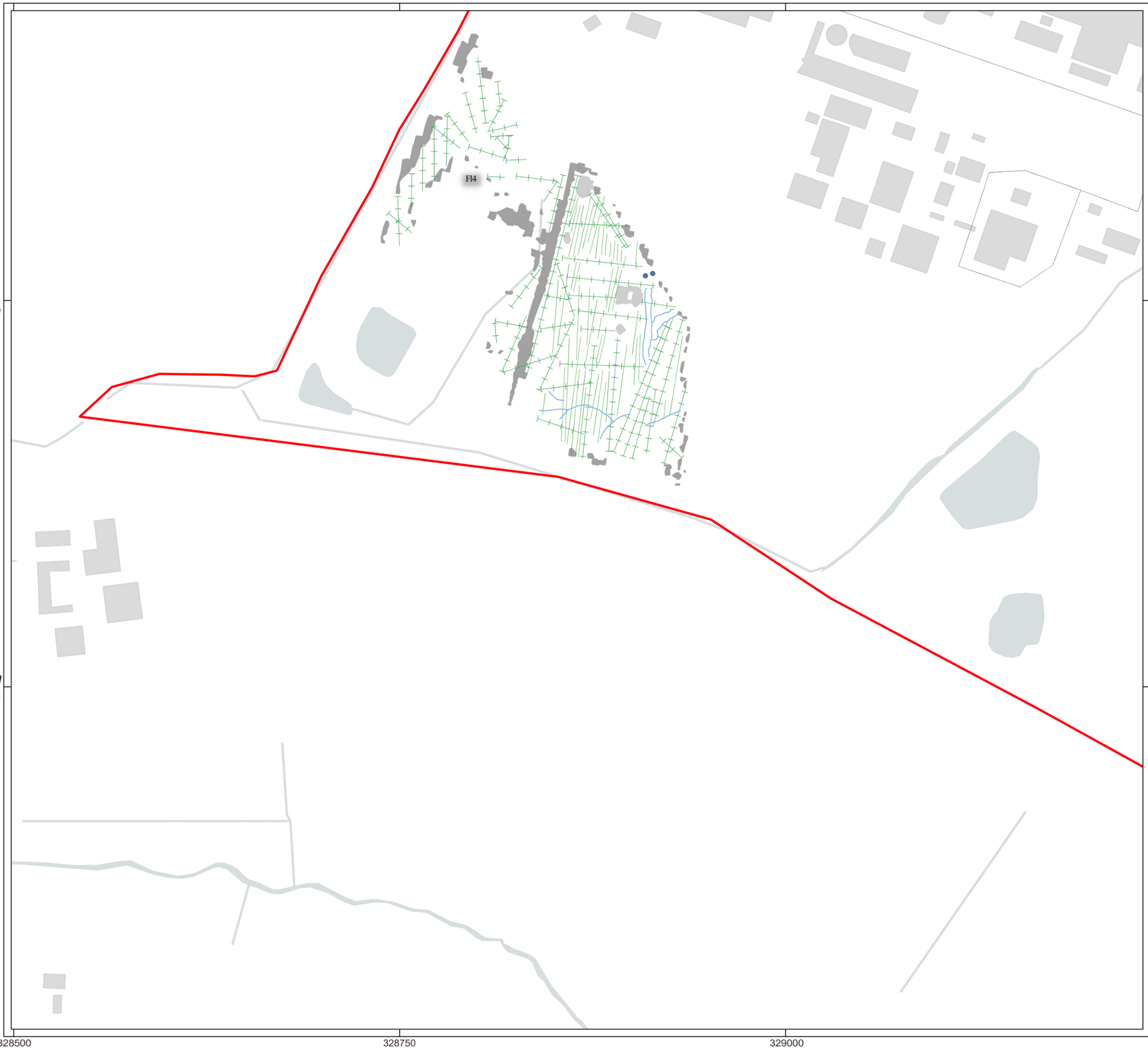
XY trace (25nT/cm)

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 16 XV trace plot of minimally processed magnetometer data; Sector 3

ILLUS 17 INTERPRETATION OF MAGNETOMETER DATA; SECTOR 3 (1:2,500)



HEADLAND ARCHAEOLOGY
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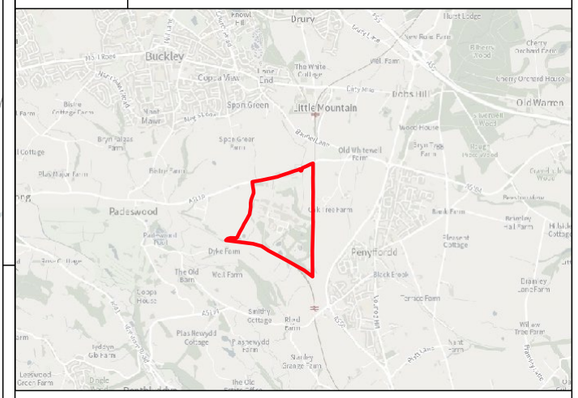

Key

- Site Boundary
- Survey Extent
- Ferrous Objects
- Agriculture
- Field Drain
- Natural
- Magnetic Disturbance (Above Ground)
- Magnetic Disturbance (Below Ground)

Abbreviations

0 60 120m

Site:	PADE23
Created by:	KSS
Checked by:	PT
Version:	v1.0
Date:	29/11/2023
Scale:	1:2,500 @A3

Illus - 17 Interpretation of magnetometer data; Sector 3

APPENDICES

APPENDIX A MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of the topsoil, subsoil, and rock, into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns, or areas of burning.

Types of magnetic anomaly

In most instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However, some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce

this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being introduced into the topsoil during manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Lightning-induced remnant magnetisation (LIRM)

LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

APPENDIX B SURVEY LOCATION INFORMATION

The magnetometer data was georeferenced using a Leica GS18 T GNSS RTK Rover outputting in NMEA mode to guide the operator and ensure full coverage, whilst maintaining a high positional accuracy of each data point; +/- 1cm for each reading.

The survey data were then super-imposed onto a base map provided by the Applicant to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX C GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX D DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.