HS2 Balfour Beatty

HS2 Phase 2a Early Environmental Works

Site 328 - Geophysics Survey Report

Heritage Non-intrusive Survey Reports Group 023

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C01	Matt Berry	Sam Harrison	Alistair Webb	31/10/2022	1st Issue

Methodology	Project Plan Site Code
Gradiometer (Magnetometer) Survey	2a20DBOWMG

Security classification: OFFICIAL

Contents

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1 Executive Summary

1.1.1 This document comprises a Final Report for a non-intrusive geophysical survey on the route of the proposed Phase 2a of High Speed Two (HS2) covering land proposed for development or likely to be impacted during the scheme as part of the Early Environmental Works (EEW) package. This report contains the results of a magnetometer survey undertaken on 10th Febuary 2022 at Site 328 within Group 023.

1.1.2 The aim of the survey is to establish the presence/absence, extent and character of detectable archaeological remains within the proposed route of HS2 Phase 2a. The scope of the surveys is dependent upon securing access to the land and for the areas to be suitable for survey.

1.1.3 EEW Group 023 is situated to the west of the town Madeley, Staffordshire, within the area to the north of Bar Hill. Site 328 is located approximately 755m north-west of the town of Madeley, to the south of Grafton's Wood and encompasses c.3.7ha. The area required for magnetometer survey consists of one irregular shaped parcel across three adjoining fields totalling c.1.7ha.

1.1.4 All suitable areas within the site were surveyed and no anomalies of archaeological or possible archaeological origin have been identified. This includes any which may relate to a potential burial mound and an area of cropmarks and geophysical anomalies to the south of Moor Hall approximately 650m to the south-east recorded in RAZ 28. There is also no evidence of anomalies which could relate to a series of Linear LiDAR/remote sensing features, possibly linked to ancient woodland at Wrinehill approximately 700m to the west.

1.1.5 The findings of the survey are limited to a pattern of field drains in the southern field, areas of magnetic disturbance caused by track matting and boundary fences and occasional and discrete, low magnitude and dipolar 'spike' anomalies are of natural and modern causes respectively.

2 Introduction

2.1 Project Background

2.1.1 HS2 is a new railway network proposed by the Government to provide a new link between London, the West Midlands, the East Midlands, South Yorkshire, Leeds and Manchester. HS2 Phase 2a comprises approximately 36 miles of railway starting at Fradley at its southern end and connects with the West Coast Main Line (WCML), south of Crewe, to allow HS2 services to join the existing network and call at Crewe Station.

2.1.2 The overall framework within which archaeological work will be undertaken is set out in the draft Environmental Minimum Requirements (EMR) for HS2 Phase 2a. Accordingly, the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

2.1.3 The works have been undertaken in accordance with Written Scheme of Investigation (WSI, HS2 2019) and conform with current best practice and guidance for geophysical surveys as outlined in the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for archaeological geophysical survey (CIfA 2014) and European Archaeologiae Consilium Guidelines for the use of Geophysics in Archaeology (EAC 2016).

2.1.4 The selection of areas required for geophysical survey included as part of this Early Environmental Works (EEW) package are set out in location specific Written Scheme of Investigations (WSIs) based on Groups containing individual sites. HS2 Ltd has provided each EEW site along the Phase 2a route with a unique identifier Site Code.

2.1.5 Within EEW Group 022 (HS2 2021) the Site Code for geophysical survey is:
• Site 328: 2a20DBOWMG

2.2 Scope of Document

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

2.3 The Site

2.3.1 EEW Group 022 is situated to the northwest of Madeley Park and south of the town of Madeley, Staffordshire. Site 328 is located approximately 755m north-west of the town of Madeley, to the south of Grafton's Wood centred at NGR 375871 345092 and encompasses c.3.7ha. The area required for magnetometer survey consists of one irregular shaped parcel across three adjoining fields totalling c.1.7ha.

2.3.2 The survey area was pasture at the time of survey and full coverage was achieved except for hedgerows and in the location of a pond. Track matting partially extended across the survey area at the time of survey.

2.3.3 Modern Ordnance Survey (OS) mapping indicates that there is a northward slope towards the River Lea. At the south-easternmost corner of the works area the height is c.120m above Ordnance Datum (aOD), approximately 310m north of this position, at the eastern site boundary closest to the River Lea, the height is c.100m aOD. The topography of the survey area slopes down to the north-west from approximately 118m aOD adjacent the animal sanctuary, down to 100m at the northern extent of the survey parcel.

2.3.4 Over the area required for survey the topography was generally flat at c.113m aOD over the large parcel off Red Lane but sloped uphill to the south to c.131m aOD at the southern extent of the survey area.

2.3.5 The solid geology across the Site is recorded as sandstone (gravelly, pebbly) of the Chester Formation. This area is overlain by deposits of till, diamicton. Overlying superficial deposits of till, diamicton and glaciofluvial sand and gravel deposits are recorded at the Site (BGS 2021).

2.3.6 The soils covering the Site are classified in Soilscape 6 Association described as freely draining slightly acid loamy soils (Cranfield University 2020).

2.3.7 Magnetometer survey can generally be recommended over any sedimentary geologies however the average responses of surveys over sandstones are generally poor but results can be variable depending on the nature and depth of the overlying deposits if present (English Heritage 2008; Table 4). It remains that magnetometry was the most appropriate geophysical technique for evaluating the Site taking account of the limitations noted in Section 4.3 below.

3 Archaeological Background

3.1 Summary of the archaeological resource

3.1.1 The following archaeological background summarises details from the Location Specific Written Scheme of Investigation (LSWSI, HS2 2021) together with information from publicly available online resources and other in-house resources.

3.1.2 The Recognised Archaeological Zones (RAZ) represent a high-level indication of likely concentrations of archaeological remains across the Phase 2a route. The location and spatial extent of RAZs has been determined using HS2 Environmental Statement (ES) Cultural Heritage information and subsequent survey data.

3.1.3 The ES (HS2 2017a) identified archaeological assets from the Historic Environment Record (HER) within the immediate vicinity of the sites comprising Group 023. The assessment and determination of the significance of archaeological assets is defined by Chapter 10 of the HS2 Ltd EIA Scope and Methodology Report (HS2 2017b). Additional information on the wider archaeological background can be found in the ES reports.

3.1.4 The HS2 Ltd Phase 2a GWSI: HERDS document identifies that the access corridor of Site 328 is located within RAZ 28. RAZ 28 is designated for a potential burial mound and an area of cropmarks and geophysical anomalies to the south-west, south, and south-east of Moor Hall farm. Geophysical survey indicated the footings of a masonry building. Together with a series of straight, linear cropmarks in the fields to the east, perhaps the most likely interpretation of this is as a Roman era building.

3.1.5 The HER identified one archaeological asset within Site 328. It comprises:

- The indicative area of a former ancient woodland (HER MST2677), Wrinehill Wood, identified through previous ecological surveys that have recorded flora species as proxy indicators. Additionally, boundary banks and ditches may be associated with the former ancient woodland. The exact date of the woodland is unknown; however, much of the woodland was extant until the mid-20th century.

3.1.6 The ES (HS2 2017c) identified one archaeological asset within the immediate vicinity from the HER within Site 328. It comprises:

- The indicative evidence of possible archaeological features (WHM061) representative of an enclosure of unknown date, was identified through magnetometer survey CA04-2876.

3.1.7 Heritage Asset data supplied from the HS2 CA5 Aerial Photograph Survey (APS) database identified no possible archaeological features within FEW group 023.

3.1.8 CA 4: Whitmore Heath to Madeley: Cultural heritage survey report (HS2 2017d) noted that geophysical survey work has partially been undertaken within Site 328. The survey, undertaken in survey area CA4-2910, partially overlapped with the north-west half of Site 328 and the features recorded in that area comprise:

- 4-2910-009: A large irregularly shaped anomaly, located in the north-west area of Site 328, interpreted as a modern spread of green waste, likely used as fertiliser. Waste spreads can mask weaker magnetic signals that could be of possible archaeological interest.

3.1.9 LiDAR/ Remote sensing survey data (HS2 2017d) identified features in the EEW Group area, which comprise:

- LiDAR ID 3091: A series of linear features can be traced within the former ancient woodland at Wrinehill. The features may, however, be natural in origin.
- LiDAR ID 3092: An area of ridge, or bank, features within former ancient woodland. The features may be related to previous woodland management. They are bounded by a ditch feature to the immediate south-east.

3.1.10 The 1840 Tithe map of the Madeley Estate indicates that Wrinehill Wood occupied the central area of Site 328 while the north-west and eastern areas had likely succumbed to assarting by this time and were arable field systems. The site remained in this configuration until the latter half of the 20th century. The Ordnance Survey 1:10,000 map of 1982 indicates that, by this time, Wrinehill Wood had been cleared and the site appeared in its present-day configuration. No additional archaeological features are evident from available historic mapping.

4 Methodology

4.1 Magnetometry

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 and Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Annex 1 and Annex 2 respectively.

4.2 Aims and Objectives

4.2.1 The aims of the survey comprise the following:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource within a specified area using appropriate methods and practices; and
- To inform either the scope and nature of any further archaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource); or a management strategy.

4.2.2 In order to achieve the above aims, the objectives of the geophysical survey are:

- To conduct a geophysical survey covering as much of the specified area as possible, allowing for on-site obstructions;
- To clarify the presence/absence of anomalies of archaeological potential; and
- Where possible, to determine the general nature of any anomalies of archaeological potential.

4.3 Assumptions and limitations

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. Magnetometry has the potential to rapidly confirm the presence/absence of a wide range of potential archaeological remains within

the site and was thus chosen as the most appropriate technique in this instance.

4.4 Fieldwork Methodology

4.4.1 The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying 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 (Figure 1). These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point, in accordance with EAC guidelines (EAC 2016).

4.4.2 Unenclosed areas were surveyed using the co-ordinates of the pre-determined Site boundary visible as an outline on the MLGrad601 software during data collection.

4.4.3 MLGrad601 (Geomar Software Inc.) software was used to collect the data.

4.5 Data processing

4.5.1 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.

4.5.2 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.

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

4.5.4 MultiGrad601 (Geomar Software Inc.) software was used to export the survey data files.

4.5.5 Terrasurveyor V3.0.37.0 (DWConsulting) software was used to process and export graphical plots the data.

5 Geophysical Survey Results and Interpretation

5.1 Gradiometer survey results and interpretation

5.1.1 The magnetometer survey was carried out on the 10th February 2022. The entire northern parcel was surveyed in full however the smaller parcel to the south could only be partially surveyed due to the presence of horses and electric fences. A total of 1.7ha was surveyed.

5.1.2 Fully processed (greyscale) data, minimally processed data (XY trace plot) and interpretative plans are presented at a scale of 1:1,500 in Figures 2 – 4 inclusive.

5.1.3 The magnetic background contains occasional low magnitude discrete anomalies likely a result of the underlying sandstone (pebbly, gravelly) geology.

5.1.4 Magnetically enhanced linear anomalies in the southern field of the site identify a pattern of field drains.

5.1.5 Magnetic disturbance caused by fences is recorded at the field boundaries and surrounding the pond in the eastern field of the site. A series of discrete, high magnitude anomalies in a linear arrangement flanking a very high magnitude spike anomaly in the central parcel of the site, records the position of track matting crossing the survey area. The high magnitude, discrete anomalies identify ferrous rivets used to connect the large sheets of aluminium track-matting which themselves do not appear magnetic.

6 Discussion

6.1 The survey has not identified any anomalies of archaeological or possible archaeological origin. This includes any which may relate to a potential burial mound and an area of cropmarks and geophysical anomalies to the south of Moor Hall approximately 650m to the south-east recorded in RAZ 28. There is also no evidence of anomalies which could relate to a series of Linear LiDAR/remote sensing features, possibly linked to ancient woodland at Wrinehill approximately 700m to the west.

6.2 The findings of the survey are limited to a pattern of field drains in the southern field, areas of magnetic disturbance caused by track matting and boundary fences and occasional, discrete, low magnitude and dipolar 'spike' anomalies are of natural and modern causes respectively.

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Cranfield University 2020 Cranfield Soil and Agrifood Institute Soilscapes http://www.landis.org.uk/soilscapes/ accessed 18th July 2022

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HS2 2019 HS2 Phase 2a Written Scheme of Investigation for EI-711 Surveys Package 1: Magnetometry (HS2-HS2-EV-MST-A000001)

HS2, 2021, Phase 2a LS-WSI: EEW Group 022, EEW Sites 314 & 316 (HS2 Document no: 2EE01-BAF-

Annex 1: 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.

Annex 2: Geophysical Interpretation

Most 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 soil 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 fencing 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.

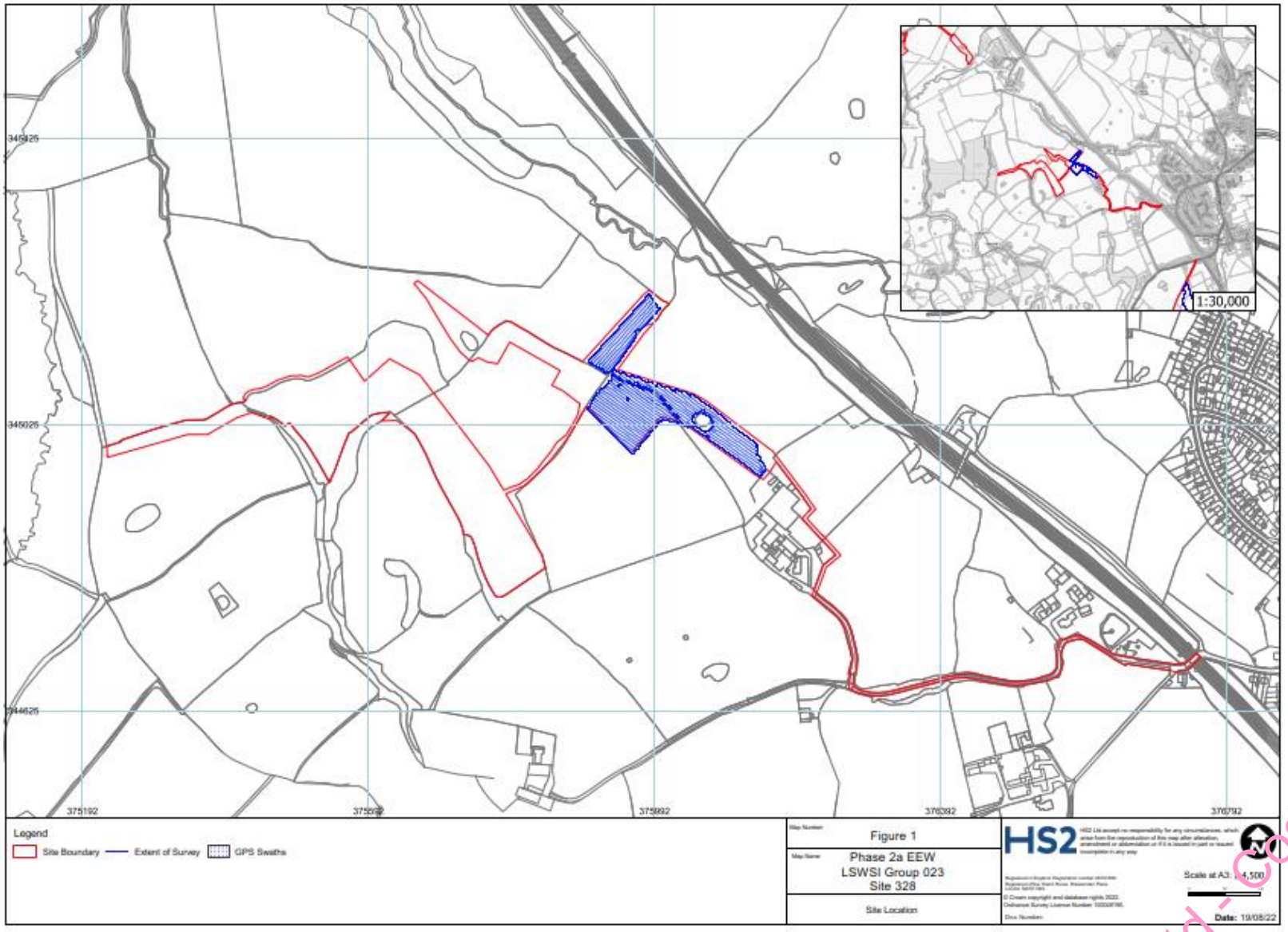
Areas of magnetic enhancement/positive isolated anomalies

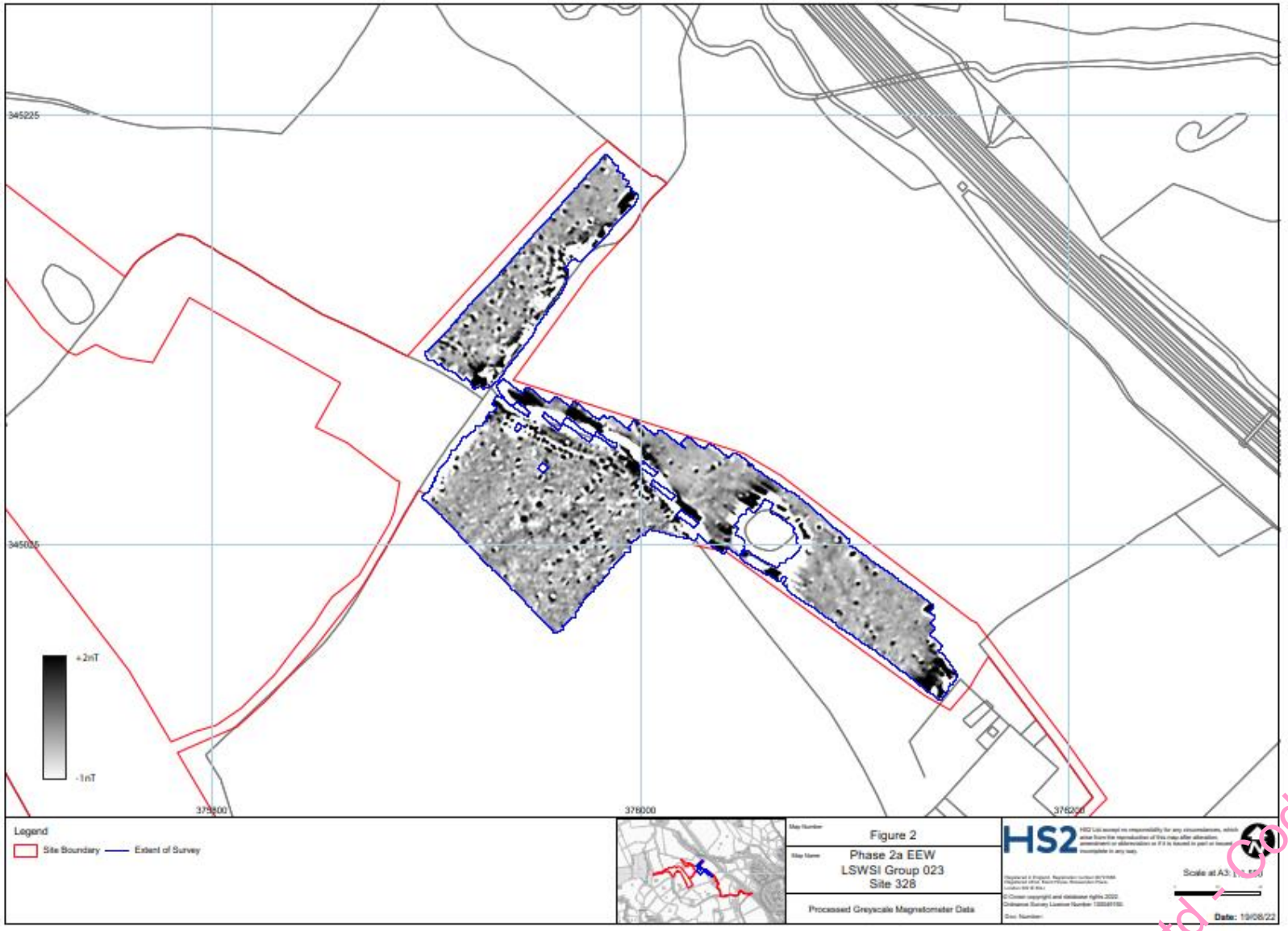
Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traces. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These

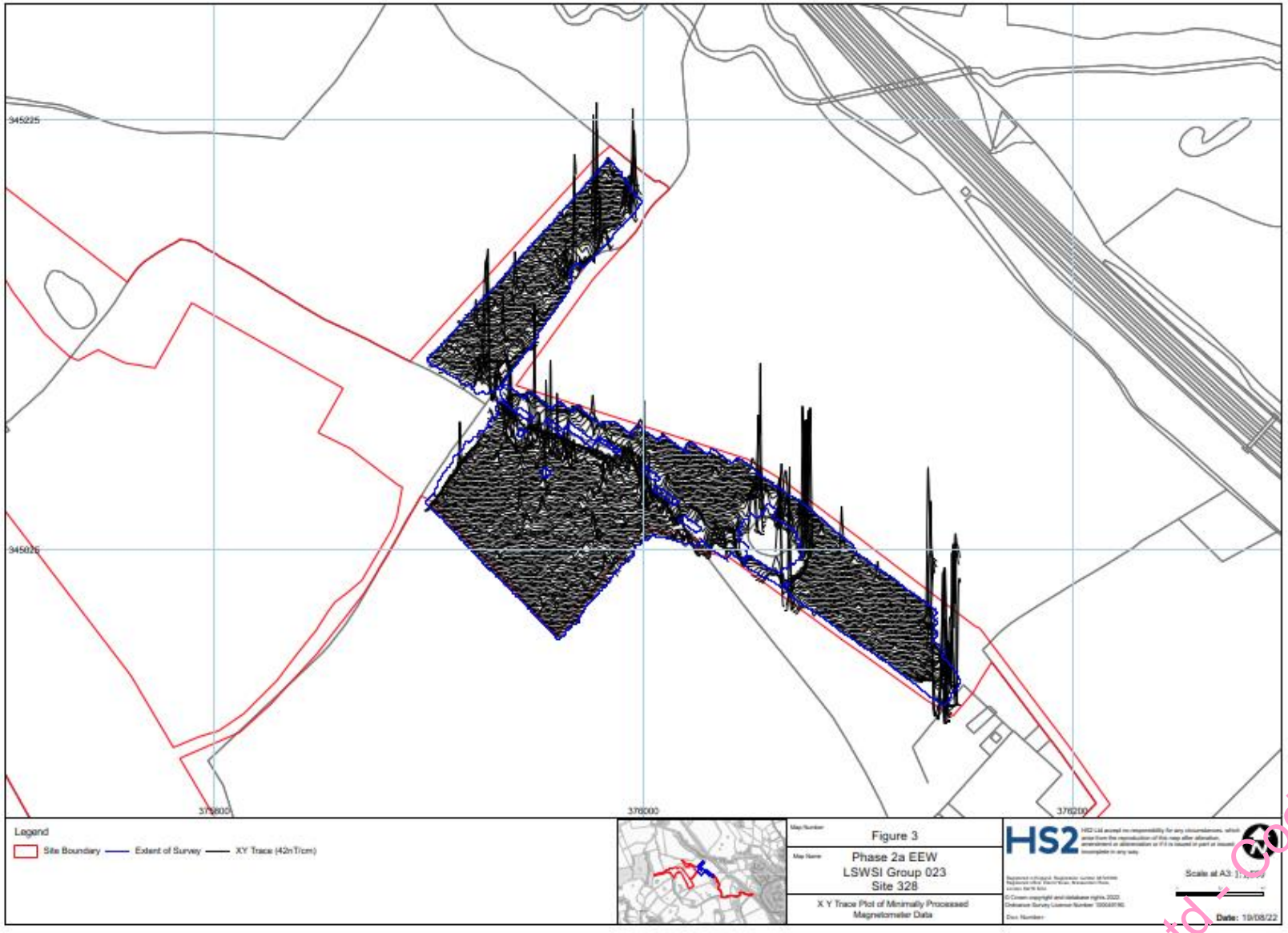
anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

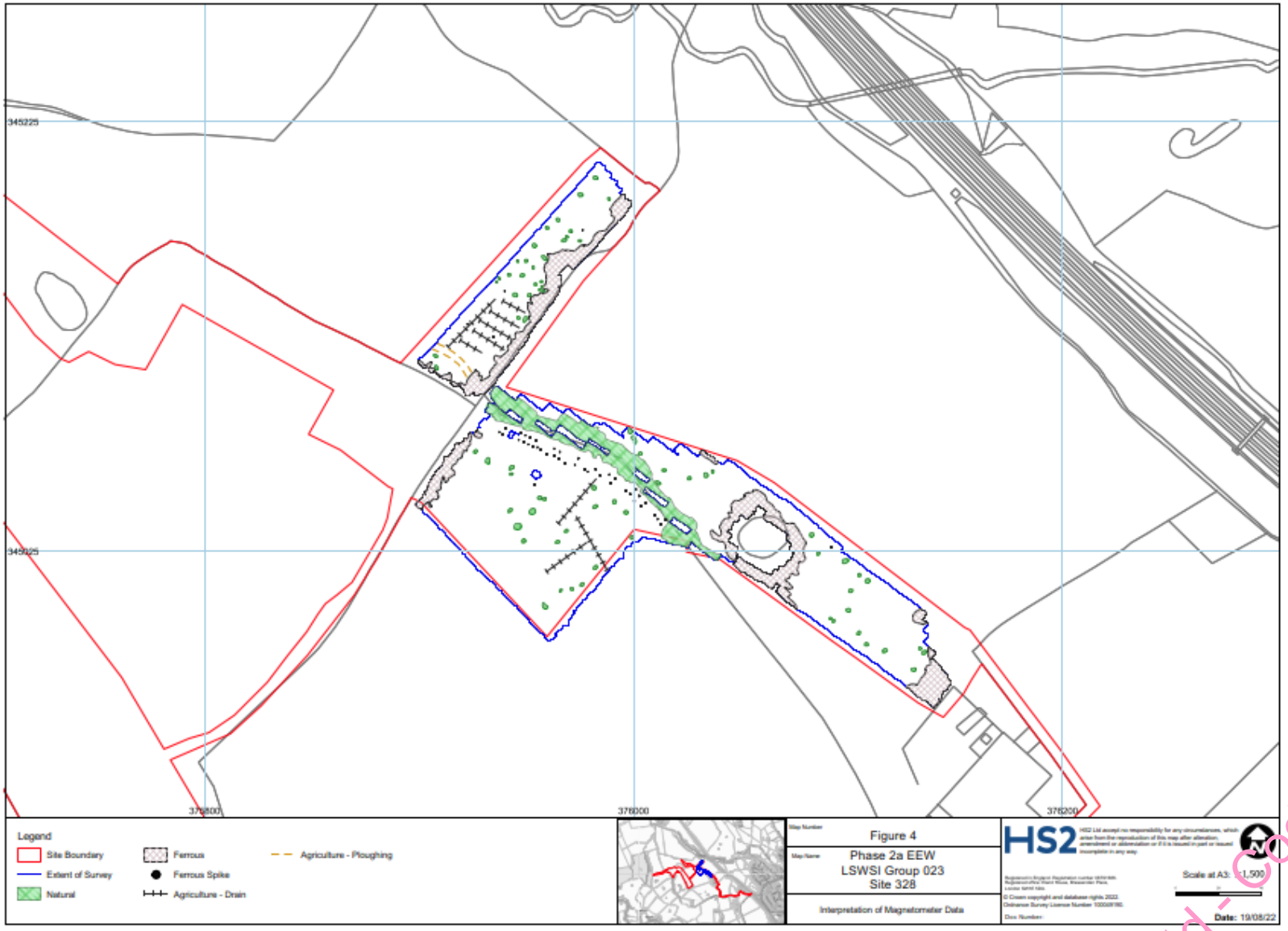
Linear and curvilinear anomalies

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.









Annex 3: OASIS Form

Project Details:

Project name	Geophysical Survey at Group 023 Site 328	
Type of project	Geophysical Survey, MAGNETOMETRY SURVEY	
Project description	The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying 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 Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point, in accordance with EAC guidelines (EAC 2016). All suitable areas within the site were surveyed and no anomalies of archaeological or possible archaeological origin have been identified. This includes any which may relate to a potential burial mound and an area of cropmarks and geophysical anomalies to the south of Moor Hall approximately 650m to the south-east recorded in RAZ 28. There is also no evidence of anomalies which could relate to a series of Linear LiDAR/remote sensing features, possibly linked to ancient woodland at Wrinehill approximately 700m to the west. The findings of the survey are limited to a pattern of field drains in the southern field, areas of magnetic disturbance caused by track matting and boundary fences and occasional and discrete, low magnitude and dipolar 'spike' anomalies are of natural and modern causes respectively.	
Project dates	**Start:** 10-Feb-2022	**End:** 10-Feb-2022

Previous work		N/A			
Future work		N/A			
Project Code:	Group 023 Site 328	**HER event no.**			

		NMR no.		**OASIS form ID:**	hs2headl1-509475
		SM no.			
Planning Application Ref.					
Site Status	None				
Land use	Arable and Pasture				
Monument type	N/A		**Period**	N/A	

Project Location:

Site Address	is located approximately 755m north-west of the town of Madeley, to the south of Grafton's Wood			**Postcode**	
County	Staffordshire	**District**	Newcastle-under-Lyme	**Parish**	Madeley
Study Area	1.7ha	**Height OD**	Between 113 and 131m Above Ordnance Datum	**NGR**	SJ 75996 45061

Project Creators:

Name of Organisation	HS2 Headland Archaeology (UK) Ltd		
Project brief originator	HS2	**Project design originator**	HS2
Project Manager	Alistair Webb	**Project Supervisor**	Matt Berry
Sponsor or funding body	Balfour Beatty	**Type of Sponsor**	Client

Project Archive and Bibliography:

Physical archive	N/A	**Digital Archive**	Geophysical survey and report	**Paper Archive**	N/A
Report title	Phase 2a Heritage Non-intrusive Surveys Report: Group 023 Site 328 Geophysics survey report			**Date**	31/10/2022
Author	Headland Archaeology	**Description**	PDF/A	**Report ref.**	