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ENVIRONMENT

Avant Homes Ltd

Calver Lane, Dodworth

Archaeology and
Heritage Statement

ENVIRONMENT

Avant Homes Ltd

Calver Lane, Dodworth

Archaeology and Heritage Statement

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1. INTRODUCTION

- 1.1 This Archaeology and Heritage Statement, prepared on behalf of Avant Homes Ltd, sets out an assessment of the potential impacts upon potential archaeological remains predicted to arise from the development of land off Calver Lane, Dodworth and any impact on the setting of designated assets and Conservation Areas.
- 1.2 In preparing the assessment of potential impacts regard is given to guidance contained within paragraph 189 of the National Planning Policy Framework (the Framework) which sets out the information requirements for proposals affecting heritage assets. It states that:

"In determining applications local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting."

2. LOCATION, GEOLOGY AND TOPOGRAPHY

- 2.1 The site comprises two parcels of land located on southern side of Dodworth. These lie either side of Smithywood Lane (**Figure 1**) at National Grid reference SE322440 043870. Residential housing estates lie to the north, east and west of the sites with agricultural land to the south.
- 2.2 The western parcel is roughly triangular in shape and c. 1.4 ha in area. The topography is slightly undulating with a slope down to the south east and a steeper slope to the south of the parcel's southern boundary. The western boundary of the parcel consists of comprises wooden garden fences associated with residential properties. Noted along the north eastern is a post and wire fence with gappy hedgerows and mature trees.
- 2.3 The eastern development parcel is c. 4.5ha in area. The topography is undulating with a general fall to the south. The north western boundary comprises wooden garden fences to existing residential properties on Calver Close. The western third of the northern boundary is open and a public footpath runs to the south. The rest of the boundary is delineated by garden fences and houses along Rockingham Road. A post and wire fences forms the eastern boundary with hedgerows and mature trees along it. The south eastern boundary is made up of dense hedgerows and mature trees.
- 2.4 There is no drift geology recorded but the solid geology comprises Coal Measures with mudstone/siltstone likely to occur on eastern boundary. Haigh Moor Rock (sandstone) is documented to the east. The Shallowest coal seam - Lidget Coal outcrops to the south of the site and Haigh Moor and Swallow Wood seams outcrop in the eastern development area.

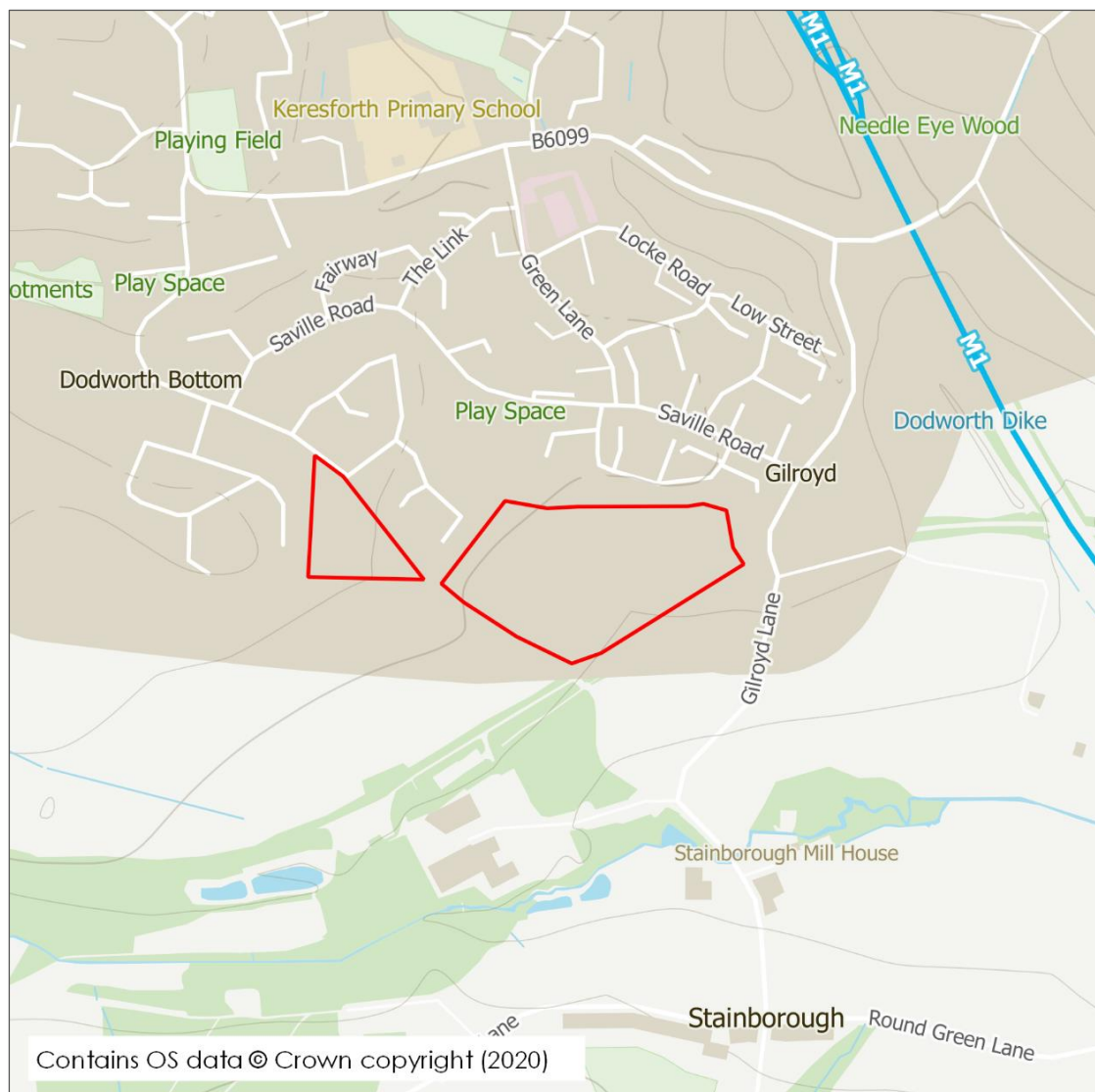


Figure 1 Site Location

3. POLICY AND ASSESSMENT GUIDANCE

Legislative Background

- 3.1 The Planning (Listed Buildings and Conservation Areas) Act 1990 (the Act) sets out the principal statutory instruments which must be considered by the decision-taker in the determination of any application affecting a listed building or conservation area.
- 3.2 Section 66 of the Act states that in considering whether to grant planning permission for development which affects a listed building or its setting, the local planning authority or, as the case may be, the Secretary of State shall have special regard to the desirability of preserving the building or its setting or any features of special architectural or historic interest which it possesses.
- 3.3 Section 69 of the Act allows local planning authorities to designate conservation areas. These are areas of special architectural or historic interest the character or appearance of which it is desirable to preserve or enhance. Section 72 requires that in the exercise

of planning duties by an authority special attention shall be paid to the desirability of preserving or enhancing the character or appearance of conservation areas.

- 3.4 Case law (see particularly *E Northants DC v Secretary of State for Communities and Local Government* [2014] EWCA Civ 137) confirms that the duties imposed under the Act indicate that where harm to a listed building or conservation area or its setting is identified this a matter to which great weight and importance should be attached in the planning balance.

National Policy and Guidance

- 3.1 Section 16 of the NPPF *Conserving and Enhancing the Historic Environment* sets out the Government's planning policies for England and how these are expected to be applied to planning policy and the historic environment.

- 3.2 The NPPF recognises that heritage assets are:

"an irreplaceable resource, and should be conserved in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of existing and future generations."

And

"That plans should set out a positive strategy for the conservation and enjoyment of the historic environment."

- 3.3 Section 16, paragraph 189, of the NPPF requires that the relevant historic environment record be consulted and any heritage assets, including any contribution made by their setting, likely to be affected by a development proposal have their significance assessed using appropriate expertise. Where an application site includes or has the potential to include heritage assets with archaeological interest, an appropriate desk-based assessment, and where necessary, a field evaluation, should be provided to inform the planning authority's decision making.
- 3.4 Section 16, paragraph 191, states that where there is evidence of deliberate neglect of or damage to a heritage asset, the deteriorated state of the heritage asset should not be taken into account in any decision.
- 3.5 Section 16, paragraph 193 of the NPPF is a fundamental consideration in determining planning applications. It states that great weight should be given to a designated heritage assets' conservation, irrespective to the level of harm to its significance.
- 3.6 Section 16, paragraph 194, of the NPPF adds that "Any harm to, or loss of, the significance of a designated heritage asset (from its alteration or destruction, or from development within its setting), should require clear and convincing justification."
- 3.7 Section 16, paragraph 195, states that a local planning authority should refused consent to a proposed development which would lead to substantial harm (or total loss of significance of) a designated heritage asset, unless it can be demonstrated that substantial public benefits outweigh the loss.

- 3.8 Section 16, paragraph 196 states that where a development proposal will lead to less than substantial harm of a designated heritage asset, the harm should be weighed against the public benefits of the proposal, including securing the optimum viable use of the asset (s).
- 3.9 Paragraph 197 states that, the effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non-designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset.

4. BASELINE ASSESSMENT

Identified Archaeological Sites, Buildings and Features

- 4.1 Aside from a small infilled late-19th century reservoir previously located in the western plot of the Site (see paragraph 1.24), no archaeological sites or historic features have been identified within, or partially within, the proposed development site. Within the 1km study area, six archaeological events and 21 monuments, including 12 listed buildings and one registered park and garden, have been recorded (**Figures 2 and 3**). These assets date from the medieval period and include archaeological features, buildings and structures.

Designated Sites or Areas

- 4.2 The study area contains 12 listed buildings, the closest of which is the Grade II Barn (**1151732**) approximately 60 metres south east of Saville Hall at the east end of the farmyard, which is situated c.300m to the west of the Site. Aside from the Grade II* Pillared Bar (**1315049**) approximately 20 metres to south of Steeple Lodge, which is located on the south-western periphery of the study area, all of the listed buildings are Grade II.
- 4.3 Approximately 420 to the south of the site is the northern limit of the Grade I Registered Park and Garden of Wentworth Castle (**1000415**) which dates to the early 18th century. The parkland associated with the castle continues southwards for approximately 2km.
- 4.4 The study area contains no scheduled monuments, World Heritage Sites, Registered Battlefields or Conservation Areas.



Figure 2 Location of Designated Heritage Assets



Figure 3 Location of Non-Designated Assets

Prehistoric and Roman periods

- 4.5 There is no known evidence within the study area dating to the prehistoric or Roman periods, though this could partly be due to the relative lack of archaeological investigations carried out around the proposed development site. However, undated features including enclosures, post-holes, pits and gullies excavated to the north-west of the study area are likely to be of prehistoric date (Richardson, 2017).
- 4.6 The geophysical survey undertaken by Phase Site Investigations does not suggest the presence of any features which may have a prehistoric or Roman date.

Early Medieval and Medieval period

- 4.7 The Domesday Book of 1086 lists Dodworth as 'Dodesuurde', meaning the enclosure of a man called Dodd or Dodda (Mills, 2003). Despite the village's medieval origins, very little remains from this period, with post-medieval and modern development obscuring the medieval nucleus. Medieval cruck cottages (**MSY4654**) were situated on the north-western periphery of the study area on Dodworth High Street, although they were demolished in c.1940.
- 4.8 The geophysical survey undertaken by Phase Site Investigations indicated to the presence of ridge and furrow with that to the south of the eastern plot and in the western parcel indicative of medieval ridge and furrow.

Post-medieval and modern period

- 4.9 The Grade I registered formal gardens of Wentworth Castle (**1000415**) were laid out in the early 18th century and are surrounded by parkland of early and mid-18th century date. The gardens and the listed buildings contained within are discussed in more detail below.
- 4.10 The study area contains several 17th century buildings and structures. These include the Grade II listed Saville Hall (**1314745**) located 360m to the west of the Site, which is a 17th century farmhouse with 19th and 20th century alterations. The Grade II listed Barn approximately 60 metres south east of Saville Hall at the east end of the farmyard (**1151732**) dates to c.1678. The Grove (**1192974**), also Grade II listed and dating to the 17th century, is a large house with 19th and 20th century alterations. This is located c.600m to the Site's northwest. Finally, the 17th century outbuilding approximately 10 metres east of Saville Hall (**1286367**) is also Grade II listed.
- 4.11 The Strafford Arms (**1151061**) is a Grade II listed Public House dating to the early 18th century, located c.600m to the south of the Site. One hundred metres to its north is the Grade II listed Kembala (**1151060**), a mid-18th century schoolroom with 20th century additions and alterations which now comprises two dwellings.
- 4.12 The Grade II* listed Pillared Barn approximately 20 metres to south of Steeple Lodge (**1315049**) located on the south-western periphery of the study area, was built in c.1775 for the second Earl of Strafford, owner of the Wentworth Castle estate (see below). Though not within the Wentworth Castle Registered Park and Garden (**1000415**), this Dutch barn was built to add interest to its former service entrance. It is early of its type and is considered to be of very unusual plan. The Grade II listed Gothic style Steeple

Lodge (**1151059**) sits 40m to its north and dates to c.1775. This was also built for the second Earl of Strafford.

- 4.13 An archaeological evaluation in 1998 on land at Dodworth High Street c.650m to the Site's northwest (**ESY75**) uncovered several buildings and a stone-lined well of post-medieval date along with pottery dating from the late 17th to 20th centuries. Targeted trenching (**ESY983**) c.120m to the southeast also uncovered a pair of late 18th or early 19th century cottages in 2007.
- 4.14 An industrial period bleachworks, or bleachery, was situated approximately 300m to the east of the Site (**MSY12123**), although the land is now occupied by an empty field. The works was operated by the firm of HJ and J Spencer of Hope Works, Barnsley from at least 1871, but by 1904 a colliery had appeared on the site of the bleachworks. Linen would have been bleached here.
- 4.15 Approximately 250m to the south of the Site lay the Strafford Main Colliery (**MSY7045**), although evidence of this has since been demolished. The proposed development site's southern boundary is a former railway line associated with the former collieries and was in operation from the mid-19th century. This is discussed further in the Cartographic Analysis below.

Wentworth Castle Park and Garden

- 4.16 Thomas Wentworth bought the Stainborough estate in 1708 and renamed it Wentworth Castle (**1000415**) in 1731. He developed the house and grounds both to help his claim to the title Earl of Strafford and to impress a rival branch of the family, the Watson Wentworths.
- 4.17 The castle itself is a Grade I listed country house (**1151065**) which lies beyond the study area to the south. It was originally built for Sir Gervase Cutler in 1670-72, although it has had several extensions and alterations since.
- 4.18 Wentworth's son, the second Earl of Strafford, continued his father's work embellishing the gardens and parkland, and the estate remained in the family until the Strafford title became extinct in 1802. The Vernon Wenworths, who took over the ownership of the estate, eventually sold the house and gardens to Barnsley Council in 1948.
- 4.19 Parts of the park were subject to opencast mining in the mid-20th century, but the land was later restored and returned to arable and pasture land. Today the c.300ha designated site begins approximately 420m to the south of the proposed development site, and four of the study area's listed buildings lie within it.
- 4.20 The Grade II Entrance Gateway and Gates to Stainborough Park (**1315050**) were built in c.1768 for the second Earl of Strafford and formed the principal entrance to the park from the north. They are located approximately 630m to the south of the Site. Fifty metres further to the south lies Menagerie House, 1-3 Park Drive (**1151062**), which is Grade II listed and dates to c.1717. This classical style banqueting house, which now comprises three cottages, was built by the Bower family, estate masons, for Thomas Wentworth, first Earl of Strafford. It was built overlooking a cascade constructed in the landscaped woods to create impressive views for the Wentworths and their guests.
- 4.21 The Grade II listed Serpentine Bridge (**1286990**) lies approximately 230m further to the southwest, and was built in 1758 for the second Earl of Strafford. Finally, lying c.920m to

the south of the Site is the Grade II listed Former Orangery on North East Side of Walled Garden to North of Home Farm (**1151072**). This probably dates to the early 19th century.

- 4.22 A brick icehouse, thought to have been built in c.1768, is also situated within the estate c.900m to the south of the proposed development site (**MSY6156**).
- 4.23 In 2006 a geophysical survey was undertaken on land c.500m to the south of the Site at the northern end of the Wentworth Castle estate (**ESY530**). The survey confirmed the location of a curvilinear cropmark, although it was not clear whether this was a former garden feature such as a ha-ha or an earlier feature.

5. CARTOGRAPHIC ANALYSIS

- 5.1 The earliest detailed map to show the proposed development site is the 1855 6 inch Ordnance Survey (OS) plan (**Figure 4**). At this time, the Site comprised seven open fields and was bounded by the Darley Main and Old Silkstone branch of the South Yorkshire Railway to the south (no longer extant). A sandstone quarry is shown to the Site's west and Lowe Reservoir is shown to the southwest beyond the railway line, although neither are extant today.



Figure 4 1855 Ordnance Survey Map

- 5.2 The 1894 6 inch OS plan (**Figure 5**) shows a rectangular pond (marked as a reservoir on later mapping) on the southern boundary of the western plot of the Site and a road/track leading to it from the west. This was evident from the geophysical survey undertaken by Phase Site Investigation in 2021. To the south beyond the railway line, *Strafford Collieries* (**MSY7045**) appear for the first time which incorporate the land previously occupied by *Lowe Reservoir*, which appears to have been drained.

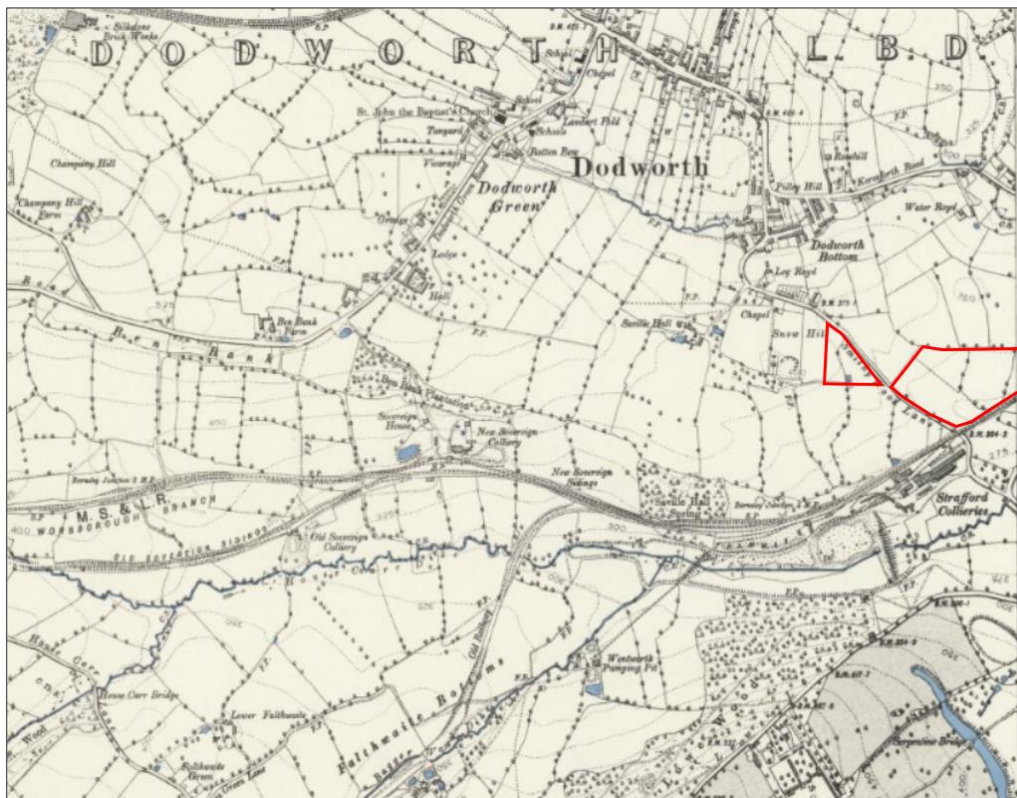


Figure 5 1894 Ordnance Survey Map

- 5.3 The 1933 6 inch OS plan (**Figure 5**) shows the Site largely unchanged, although one of the field boundaries in the eastern plot had been removed. *Stratford Collieries* had expanded northwards over the railway line, but not into the Site itself.

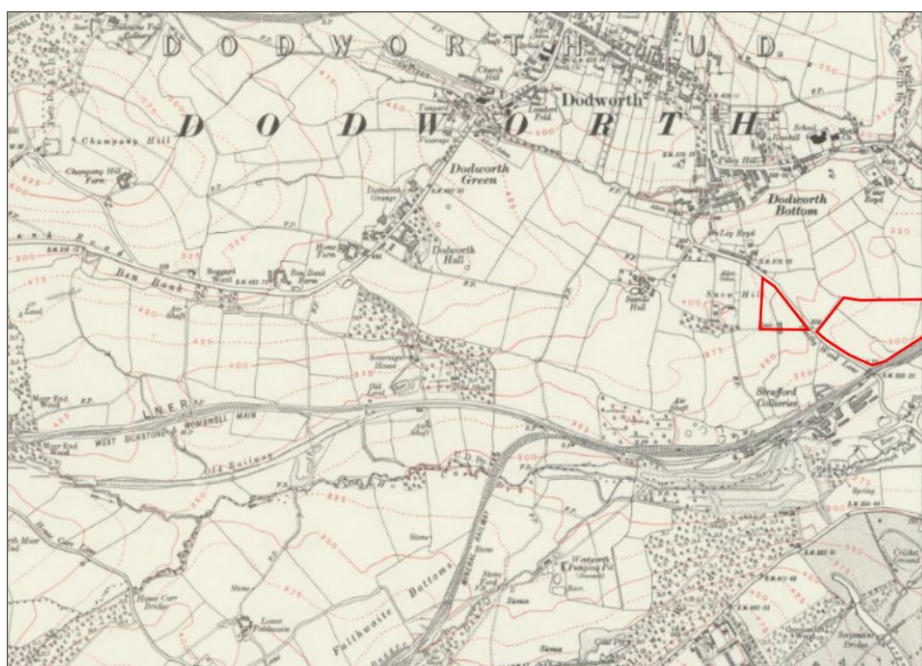


Figure 6 1933 Ordnance survey Map

- 5.4 By the time of the 1949 6 inch OS plan (**Figure 6**), a housing estate had been built to the immediate west of the Site on what is currently Intake Crescent. The reservoir in the Site's western plot is still marked and the remainder of the Site appears to have remained unchanged.



Figure 7 1949 Ordnance Survey Map

- 5.5 Finally, the 1955 1:25,000 OS plan (**Figure 7**) shows the Site unchanged. The reservoir is not shown, though this could be due to the map's relative lack of detail. By this point, *Stratford Collieries* to the south were disused but the railway line was still extant.

6. GEOPHYSICAL SURVEY

- 6.1 A geophysical survey was undertaken by Phase Site Investigations in March 2021 (**Appendix 1**). The equipment used for this comprised a multi-sensor array cart system (MACS) which comprises 6 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger.
- 6.2 The purpose of the survey was to determine the presence / absence features within the site including those relating to post-medieval/ modern mining activities. Most of the anomalies identified relate to modern material /objects, agricultural activity and geological /pedological variations. There are some features which comprise linear and curvi-linear trends the predominance of which are thought to relate to agricultural, drainage or other modern activity or natural features / variations. However, there are some anomalies which may be archaeological in origin although there is no clear pattern patterns to these anomalies.

- 6.3 The survey identified several isolated responses which are caused by modern objects / material or natural features, such as ironstone nodules.

7. CONCLUSIONS

- 7.1 There are no designated sites or areas within the proposed development site. The 1km study area contains 21 monuments, 12 of which are listed buildings. Aside from a Grade II* listed barn situated on the south-western periphery of the 1km radius study area, these are all Grade II. The closest of these is located c.300m to the west of the site. Approximately 420m to the south of the Site lies the Grade I Registered Park and Garden of Wentworth Castle, which dates to the early 18th century. None of these assets will be affected by the proposed development given intervening landscape or built form.
- 7.2 The proposed development site appears to have remained largely undeveloped throughout its history, although cartographic evidence shows that a small infilled reservoir dating to the late-19th century previously sat in the western plot of the Site.
- 7.3 Archaeological evidence within the study area dates back to the medieval period, but undated features including enclosures, post-holes, pits and gullies excavated to the north-west of the study area are likely to be of prehistoric date. Several collieries operated in the local area from the mid to late-19th century, the closest of which was situated c.250m to the south of the Site. A sandstone quarry was also located a short distance to the west of the Site.
- 7.4 Aside from the known infilled reservoir, the archaeological potential of the Site is considered to be low which is highlighted by the geophysical survey results. On the basis of this no further works are proposed.

8. BIBLIOGRAPHY

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APPENDICES

APPENDIX 1
Geophysical Survey Report



PHASE
SITE INVESTIGATIONS

**Smithy Wood Lane
Dodworth, South Yorkshire**

Archaeological geophysical survey

Project No. ARC/3067/1154

May 2021



Smithy Wood Lane Dodworth, South Yorkshire

Archaeological geophysical survey

Project No. ARC/3067/1154

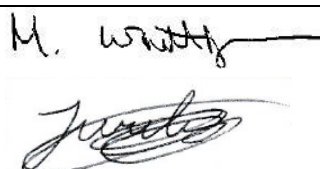
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1. SUMMARY

Phase Site Investigations Ltd was commissioned to carry out a magnetic gradient survey at a site off Smithy Wood Lane, Dodworth, South Yorkshire. The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS). The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The MACS data was collected on profiles spaced 0.5 m apart with readings taken at between 0.1 and 0.15 m intervals.

The majority of the anomalies identified by this survey relate to modern material / objects, agricultural activity and geological / pedological variations. There are a number of linear curvi-linear trends across the survey area but the majority of these are probably related to agricultural, drainage or other modern activity or natural features / variations. There are some responses whose cause is less certain. It is possible that some of these could be caused by other sub-surface features and as such an archaeological origin cannot be completely ruled out, although there is no clear evidence or patterns to the anomalies that would indicate they are related to archaeological features / activity.

There are a large number of isolated responses across the site. Many of these have been targeted by intrusive investigation to determine if they related to mining features / activities. In all cases the targeted isolated anomalies were found to be caused by modern objects / material or natural features, such as ironstone nodules. It is understood that there were no indications that any of these responses were found to be associated with pits or areas of burning that could be related to archaeological features / activity.

2. INTRODUCTION

2.1 Overview

Phase Site Investigations Ltd was commissioned by Avant Homes Yorkshire to carry out an archaeological geophysical survey at a site off Smithy Wood Lane, Dodworth, South Yorkshire, utilising magnetic gradiometers.

The aim of the survey was to help establish the presence / absence, extent, character, relationships and date (as far as circumstances and the inherent limitations of the technique permits) of archaeological features within the survey area.

The survey was part of a larger geophysical survey incorporating magnetic, electromagnetic (EM) and electrical resistivity imaging (ERI) techniques. The combined geophysical survey was undertaken to help determine if unrecorded mineshafts or other mine workings were present within the survey area(s) and to try to locate a geological fault that is believed to cross the site and is discussed in a separate report (Phase Site Investigations Ltd, 2021). The magnetic data has been reinterpreted for this report to discuss the anomalies in an archaeological context.

The location of the site is shown in drawing ARC_3067_1154_01.

2.2 Site description

The site is situated off Smithy Wood Lane, Dodworth, South Yorkshire (approximate NGR SE 323 044).

The survey covered one field, which was under grass, and part of a second arable field. The two fields were separated by Smithy Wood Lane. For the purposes of this survey the part of the arable field to the south-west of Smithy Wood Lane has been labelled Area 1 and the larger field to the north-west of Smithy Wood Lane has been labelled Area 2.

Area 1 covered an area of approximately 1.4 ha and was relatively level with a gradual slope downwards to the east. The area was bounded by wooden garden fences to the west, post and wire fencing and hedges / dense vegetation to the north-north-east and east with no fixed boundary to the south.

Area 2 covered an area of approximately 4.4 ha and was undulating with a general downwards trend from west to east and a gradual slope downwards in the east of the field from north to south. The western and parts of the northern and eastern boundaries consisted of wooden garden fences and hedges / dense vegetation. Part of the northern boundary (in the north-west) was open and the remainder of the field was bounded by hedges, trees, dense vegetation and some fencing.

The geology of the majority of the site consists of mudstone, siltstone and sandstone of the Pennine Middle Coal Measures. Coal seams (Swallow Wood and Haigh Moor Coal) cross the site and a band of sandstone of the Haigh Moor Rock crosses the easternmost field. There are no recorded superficial deposits across the site (British Geological Survey, 2021).

2.3 Background

An archaeological / heritage desk-based assessment was not available at the time of writing this report.

A geoenvironmental appraisal (Lithos Consulting, 2021) indicates that historic maps show that a reservoir to be present within Area 2 but this is no longer visible on site. The reservoir

was targeted by intrusive investigation and was identified and found to contain made ground (gravelly clay with some brick) to a depth of 0.7 m. The geoenvironmental appraisal indicated that there are no recorded mining features within the site but it lies in an area of coal mining activity.

The EM and magnetic survey identified a number of isolated anomalies that had potential to be related to mining features but intrusive investigation confirmed that all of these were caused by modern material or natural variations (isolated sand and gravel deposits and ironstone nodules – some of the latter in excess of 1 m in size.). No shafts or infilled pits were identified.

Historic maps (old-maps.co.uk, 2021) indicate that the site has been in use for agriculture since before 1855. They also indicate that Area 2 used to be sub-divided into smaller fields.

2.4 Scope of work

The survey area was specified by the client.

Due to the presence of dense vegetation adjacent to some field boundaries the area accessible / suitable for survey was reduced slightly to approximately 5.7 ha, the extents of which are shown in drawing ARC_3067_1154_02.

No problems were encountered during the survey which was carried out on between 22 and 25 March 2021.

3. SURVEY METHODOLOGY

3.1 Magnetic survey

The survey was undertaken using a Phase Site Investigations Ltd multi-sensor array cart system (MACS).

The MACS comprised 8 Foerster 4.032 Ferex CON 650 gradiometers with a control unit and data logger. The Foerster gradiometers do not require balancing as each sensor is automatically 'zeroed' using the control unit software.

A MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead, an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.

Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK OSTN15 projection.

3.2 Data processing and presentation

The MACS data was stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

The data is relatively 'noisy' and so greyscale plots of the data have been shown at two ranges; a range of -2 nT to 3 nT, which is 'standard' for archaeological surveys and a relatively wide (for archaeological surveys) range of -5 to 5 nT. The latter smooths out the data and can make it easier to identify some anomalies but very weak responses may not be visible in the wider range.

The data was exported as raster images (PNG files). A greyscale plot is presented at a clip of -2 nT to 3 nT in drawing ARC_3067_1154_02 (scale 1:2000) and a greyscale plot with an accompanying interpretation at a clip of -5 nT to 5 nT in drawings ARC_3067_1154_03 through ARC_3067_1154_06 (scale 1:1250). Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated. The two different ranges that the data has been displayed at show that the magnetic disturbance, although present across the majority of the site, is less noticeable in the wider range (-5 nT to 5 nT). This indicates that much of the magnetic disturbance is probably caused by relatively small surface / near surface material.

The data has been displayed relative to a digital base plan provided by the client as drawing "SWL-BWB-00-ZZ-M2-G-001_Existing_Site_2D_Mode.dwg.dwg". The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids / data were



referenced directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar and bipolar responses that will probably be associated with surface / near-surface iron objects. However, X-Y trace plots have not been presented here as they do not show any additional anomalies that are not visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot is provided in the digital archive.

All isolated responses have been assessed using a combination of greyscale and X-Y trace plots. There are a large number of 'iron spike', isolated dipolar anomalies present in the data. There is no evidence to suggest that they are associated with archaeological features and so these have not been shown in the interpretation.

Anomalies associated with agricultural regimes are present in the data but each individual anomaly has not been shown on the interpretation. Instead, the general orientation of the regime is indicated.

The data was examined over several different ranges during the interpretation to ensure that the maximum information possible was obtained from the data.

The anomalies have been categorised based on the type of response that they exhibit and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided.

A general discussion of the anomalies is provided for the entire site and then the results are discussed on an area by area basis. A discussion of the general categories of anomaly which have been identified by the survey is provided in Appendix 1.5.

The geophysical interpretation drawing must be used in conjunction with the relevant results section and appendices of this report.

4. RESULTS

4.1 General

The data quality across the majority of the survey area is good allowing the data to be viewed at a relatively narrow range of readings to better identify weak anomalies. There are several areas that have a more disturbed / variable magnetic background but this is due to the presence of magnetic material in the topsoil or sub-surface, rather than low data quality.

As discussed above (Section 2.3) a large number of isolated responses have already been investigated to determine if they may be related to mining activity. None of the responses were found to relate to pits or shafts and in all cases either modern material or ironstone nodules were identified. Smaller isolated responses have therefore not been shown on the interpretation as these will not have any archaeological potential. Some larger responses have been shown, to indicate where there may be a larger feature or greater amount of modern material but these are also not significant from an archaeological perspective.

4.2 Area 1

Basic topography:	Relatively level with a gradual slope downwards to the east.
Area description:	Arable field with no visible crop. The area was relatively firm underfoot and was bounded by wooden garden fences to the west, post and wire fencing and hedges / dense vegetation to the north-east and east. There was no fixed boundary to the south.
Summary of anomalies:	Numerous isolated dipolar and small bipolar responses, which will all be associated with modern material or natural variations. These have not been shown on the interpretation. Several larger isolated bipolar responses have been shown. These will be related to concentrations of, or larger objects or features, of relatively modern ferrous or fired material. They are not be archaeological significant but have been shown to highlight areas where there may be significant relatively modern material / objects. Areas of magnetic disturbance associated with relatively modern features / material. Very strong responses associated with strongly magnetic relatively modern features / material. These responses can extend for some distance beyond the feature and in some cases the feature causing the strong response may be located beyond the survey area. There are a number of negative linear / curvi-linear responses. These responses are either related to the historic reservoir that was in this field or agricultural features. Positive linear responses are present associated with modern ploughing regimes. Trends of uncertain origin.

Numerous isolated positive responses. Many of these are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

Anomalies A and B are isolated responses that were previously highlighted as having potential to be associated with mining activity. It is understood that all of Anomalies A and a majority of Anomalies B were investigated intrusively to confirm their cause. No features relating to mining activity were identified and it is understood that no pit features or other features / variations that could be associated with archaeological features / activity were observed. It is probable that all of the other isolated responses in this area relate to either modern material or natural features / variations.

A number of linear trends and an area of magnetic disturbance (**Anomalies C**) correspond with the location of a historic reservoir and will be related to the feature and material infilling it. The location of the reservoir has been confirmed by intrusive investigation. There are several trends (**Anomalies D**) that may connect to, or respect responses associated with the former reservoir and could be caused by related features. It is possible however that some of these responses are unrelated to the reservoir and they could therefore be caused by archaeological features. Towards the north of the area there are a number of small trends and some isolated responses (**Anomalies E**). These could be related to anthropogenic activity but their exact cause is not certain.

Several trends are present in the north and west of the area that run slightly oblique to the obvious agricultural regimes (**Anomalies F**) or which appear to form curving shapes (**Anomalies G**). It is possible that some of these could be related to sub-surface features but it is more likely that they are also related to agricultural or other relatively modern activity.

There are several other smaller trends in the vicinity of Anomalies C and D and which could be caused by related features / activity but it is also possible that these are caused by agricultural activity, natural variations or a combination of both.

The remaining trends within the survey area are all too weak and short to reliably interpret. They do not form any patterns or relationships that would suggest they are associated with sub-surface features and it is likely that they are simply a product of the agricultural activity or natural variations.

4.3 Area 2

Basic topography:	Undulating with a general downwards trend from west to east and a gradual slope downwards in the east of the field from north to south.
Area description:	Grass field. The area was relatively soft underfoot. The western and parts of the northern and eastern boundaries of the area consisted of wooden garden fences and hedges / dense vegetation. Part of the northern boundary (in the north-west) was open and the remainder of the field was bounded by hedge, trees, dense vegetation and some fencing.
Summary of anomalies:	Numerous isolated dipolar and small bipolar responses, that are all thought to be associated with modern material. These have not been shown on the interpretation.

Several larger isolated bipolar responses have been shown. These will be related to concentrations of, or larger objects or features, of relatively modern ferrous or fired material. They are not archaeologically significant but have been shown to highlight areas where there may be significant relatively modern material / objects.

Areas of magnetic disturbance associated with relatively modern features / material.

A linear bipolar anomaly corresponds with the position of a former field boundary. The response will either be related to this feature or an associated sub-surface material / feature (such as pipe or drain or track).

Very strong responses associated with strongly magnetic relatively modern features / material. These responses can extend for some distance beyond the feature and in some cases the feature causing the strong response may be located beyond the survey area.

Broad areas of positive and negative responses and diffuse trends are present that will be associated with natural features or variations.

A series of broadly parallel positive linear responses are present associated with modern ploughing regime(s).

Other broadly parallel positive linear responses are present that will be related to agricultural activity but it is not certain if these are caused by ridge and furrow, drainage or modern ploughing.

A linear trend corresponds with the position of a former field boundary and will be related to this feature.

Trends of uncertain origin.

Numerous isolated positive responses. Many of these are probably geological / pedological in origin or related to relatively modern deeper buried ferrous / fired material.

Further discussion / additional information:

Anomalies A and B are isolated responses or discrete areas of strong responses that were previously highlighted as having potential to be associated with mining activity. It is understood that all of Anomalies A and a majority of Anomalies B were investigated intrusively to confirm their cause. No features relating to mining activity were identified and it is understood that no pit features or other features / variations that could be associated with archaeological features / activity were observed. It is probable that all of the other isolated responses in this area relate to either modern material or natural features / variations.

There is a bipolar linear response present that appears to terminate in this field (**Anomaly H**). Bipolar linear responses are usually related to modern sub-surface apparatus, such as pipes, drains or cables. However, Anomaly H corresponds to the position of a former field boundary shown on historic maps. Anomaly H could be related to the field boundary or an



associated feature but it is also possible that sub-surface apparatus is present, which ran adjacent to the former boundary.

There are numerous trends across this area. Some broad, diffuse responses are suggestive of natural features / variations. Other trends (**Anomalies I**) are indicative of agricultural or drainage features but some are of uncertain origin. **Anomalies J** are probably also related to agricultural or drainage activity but this interpretation is less certain and some of them could be caused by other sub-surface features.

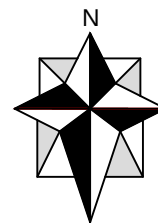
The remaining trends within the survey area are all too weak and short to reliably interpret. They do not form any patterns or relationships that would suggest they are associated with sub-surface features and it is likely that they are simply a product of the agricultural activity or natural variations.

5. DISCUSSION AND CONCLUSIONS

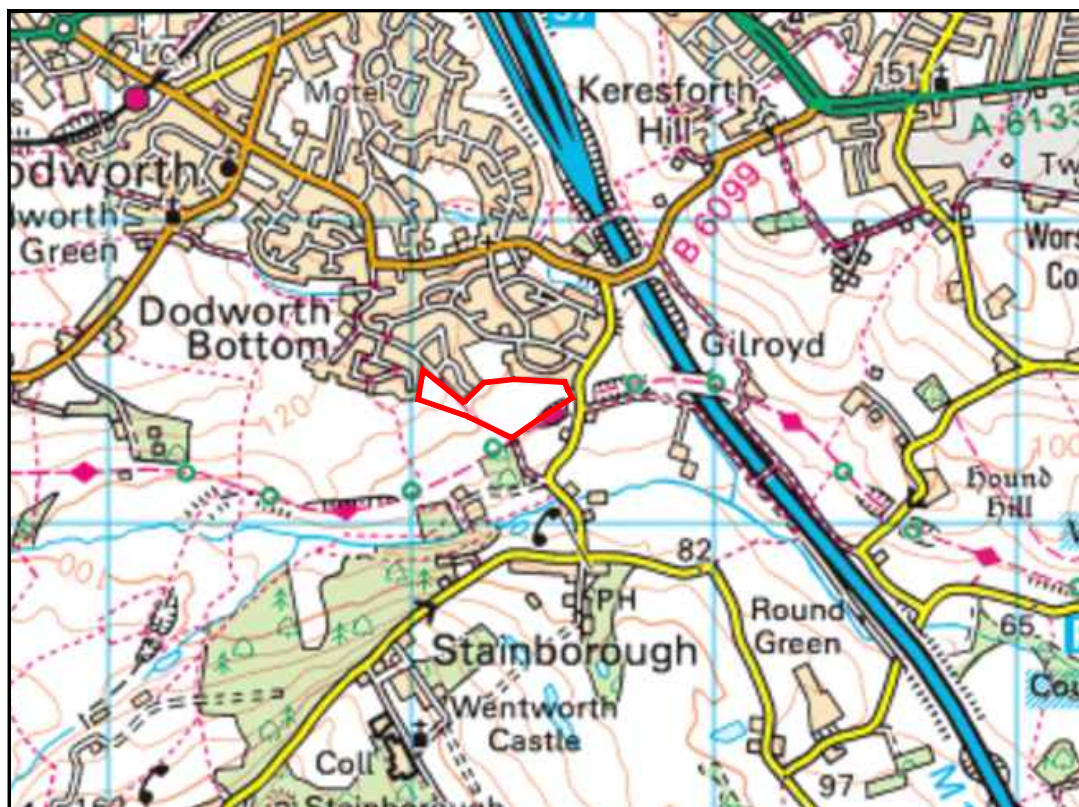
The majority of the anomalies identified by this survey relate to modern material / objects, agricultural activity and geological / pedological variations. There are a number of linear curvi-linear trends across the survey area but the majority of these are probably related to agricultural, drainage or other modern activity or natural features / variations. There are some responses whose cause is less certain. It is possible that some of these could be caused by other sub-surface features and as such an archaeological origin cannot be completely ruled out, although there is no clear evidence or patterns to the anomalies that would indicate they are related to archaeological features / activity.

There are a large number of isolated responses across the site. Many of these have been targeted by intrusive investigation to determine if they related to mining features / activities. In all cases the targeted isolated anomalies were found to be caused by modern objects / material or natural features, such as ironstone nodules. It is understood that there were no indications that any of these responses were found to be associated with pits or areas of burning that could be related to archaeological features / activity.

It should be noted that a geophysical survey does not directly locate sub-surface features - it identifies variations or anomalies in the background response caused by features. The interpretation of geophysical anomalies is often subjective and it is rarely possible to identify the cause of all such anomalies. Not all features will produce a measurable anomaly and the effectiveness of a geophysical survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a geophysical survey will identify all sub-surface features. Confirmation on the identification of anomalies and the presence or absence of sub-surface features can only be achieved by intrusive investigation.



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05

04



SITE LOCATION

SCALE



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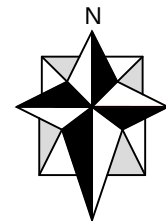


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Scale	[A4 Sheet]	Drawing	Status
AS SHOWN		ARC_3067_1154_01	FINAL
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Site	SMITHY WOOD LANE DODWORTH, SOUTH YORKSHIRE		
Title	SITE LOCATION MAP		
Job No	ARC_3067_1154		
Chk.	NF	Drawn	CW
		Date	06/04/2021



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KEY

— SITE BOUNDARY



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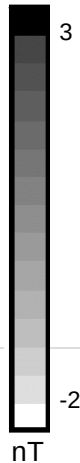
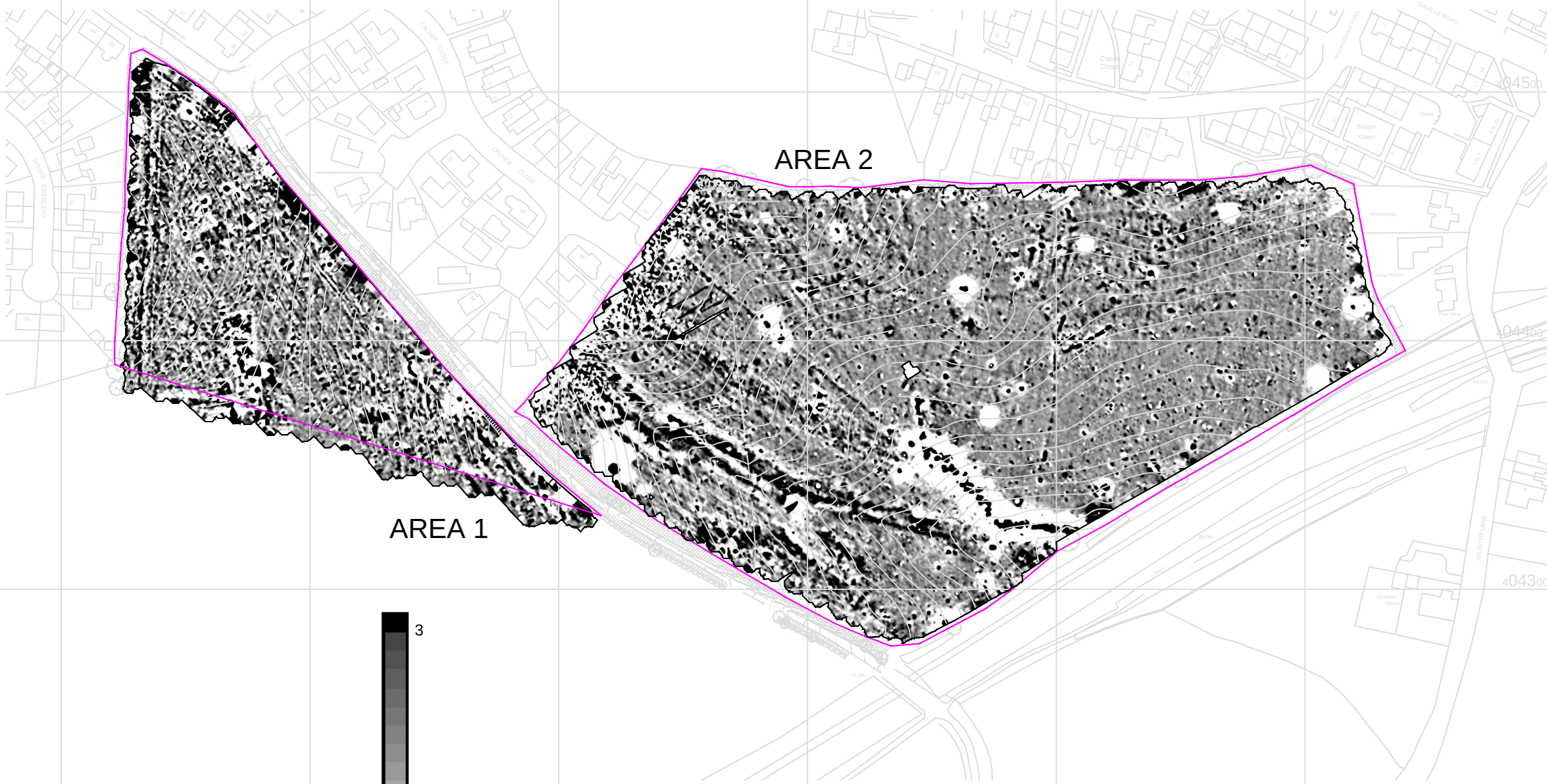
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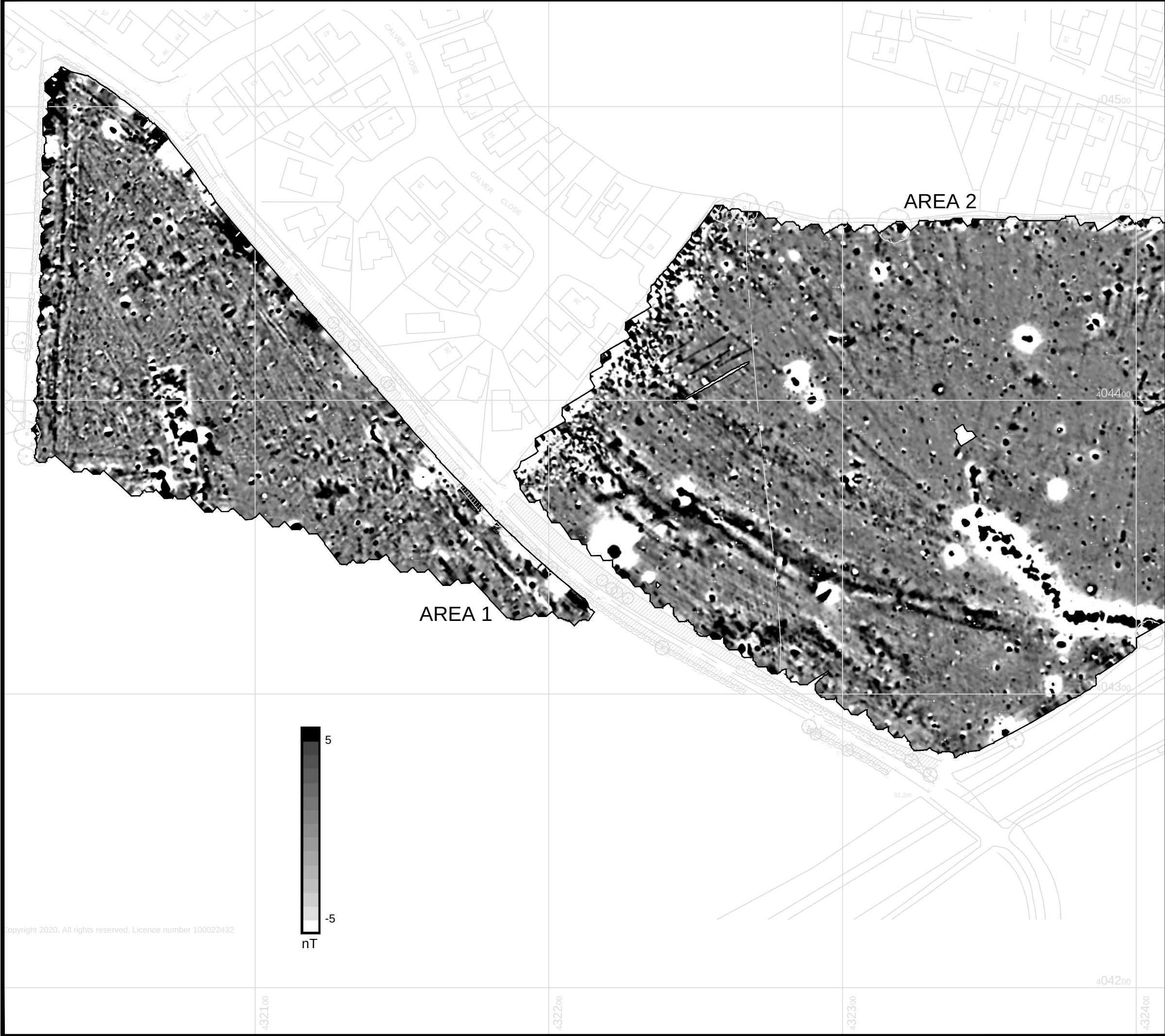
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Title	LOCATION OF SITE SHOWING MAGNETIC GRADIENT DATA (‘STANDARD’ RANGE)
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Job No	ARC_3067_1154
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Surveyed	AM, SBC, PW	Drawn	MW, JW
Chk.	NF	Date	25/03/2021



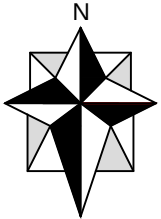


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Site	SMITHY WOOD LANE DODWORTH, SOUTH YORKSHIRE		
Title	GREYSCALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 1 AND WESTERN PART OF AREA 2 ('WIDER' RANGE)		
Job No	ARC_3067_1154		
Surveyed	AM, SBC, PW	Drawn	MW, JW
Chk.	NF	Date	25/03/2021

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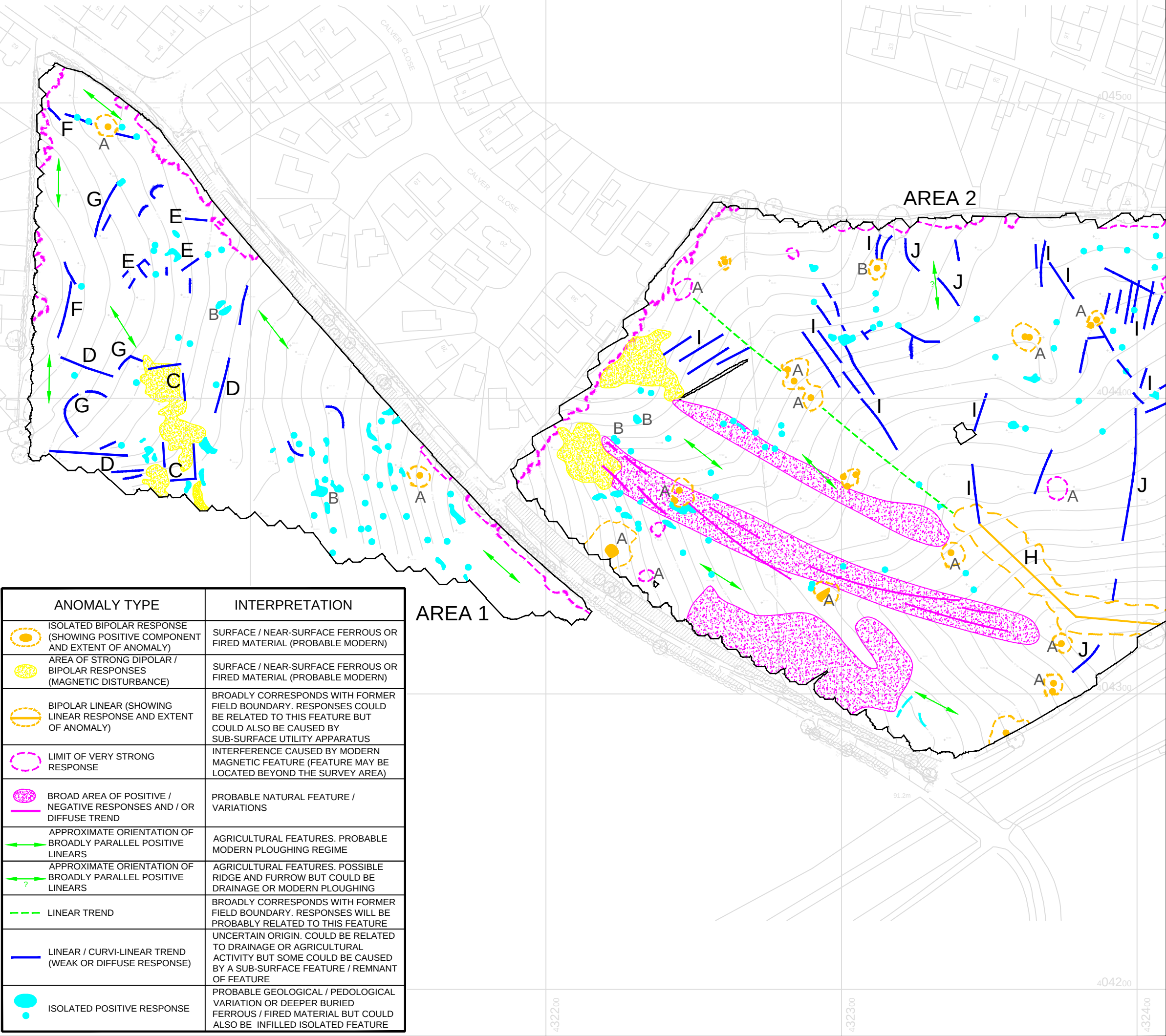
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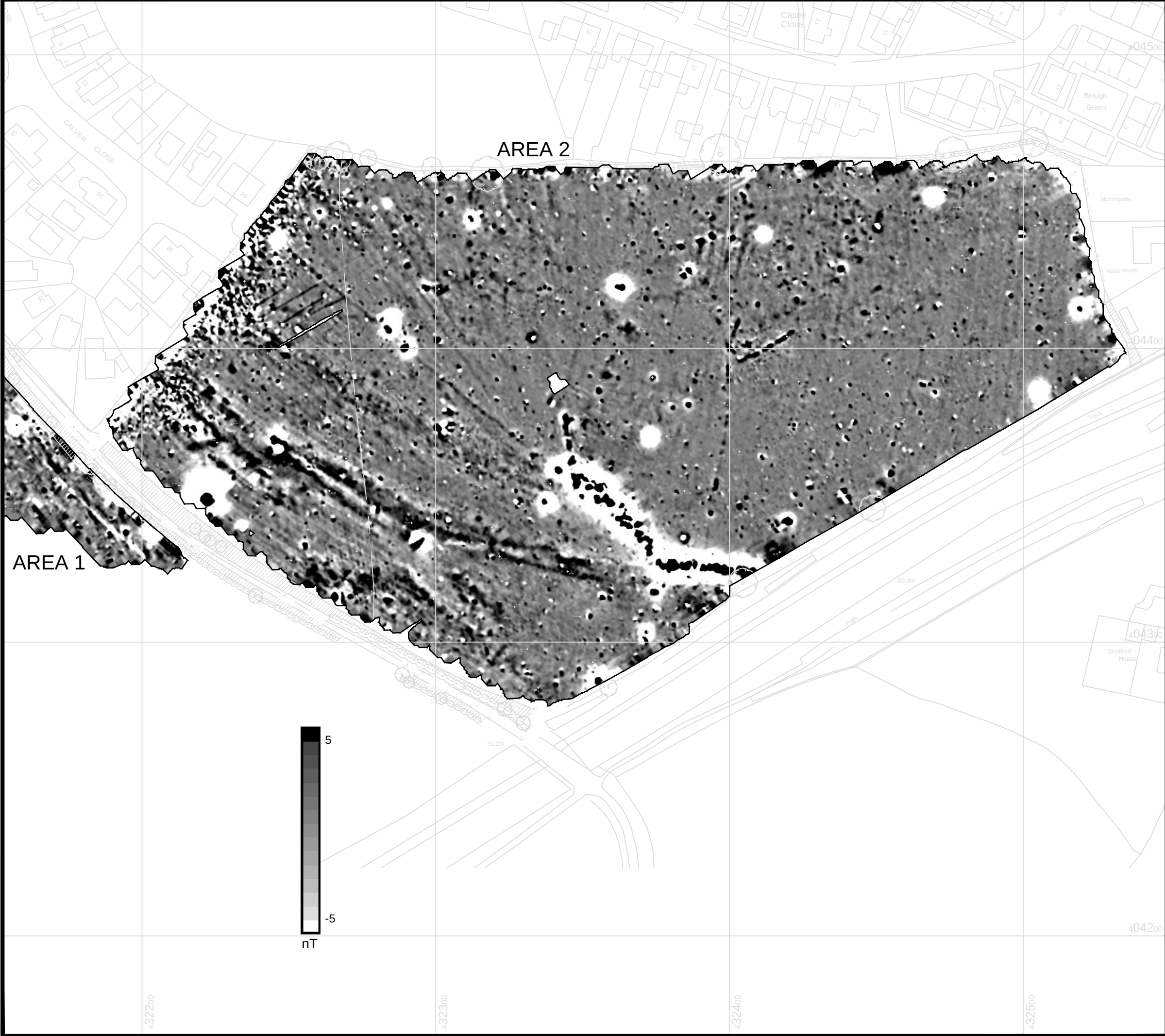
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Title	INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 1 AND WESTERN PART OF AREA 2
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Job No	ARC_3067_1154
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Surveyed	AM, SBC, PW	Drawn	MW, JW
Chk.	NF	Date	25/03/2021

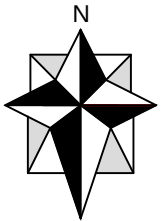




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Scale	[A3 Sheet]	Drawing	Status
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Client	AVANT HOMES YORKSHIRE WAKEFIELD		
Site	SMITHY WOOD LANE DODWORTH, SOUTH YORKSHIRE		
Title	GREYSKALE PLOTS OF MAGNETIC GRADIENT DATA: AREA 2 AND PART OF AREA 1 ('WIDER' RANGE)		
Job No	ARC_3067_1154		
Surveyed	AM, SBC, PW	Drawn	MW, JW
Chk.	NF	Date	25/03/2021

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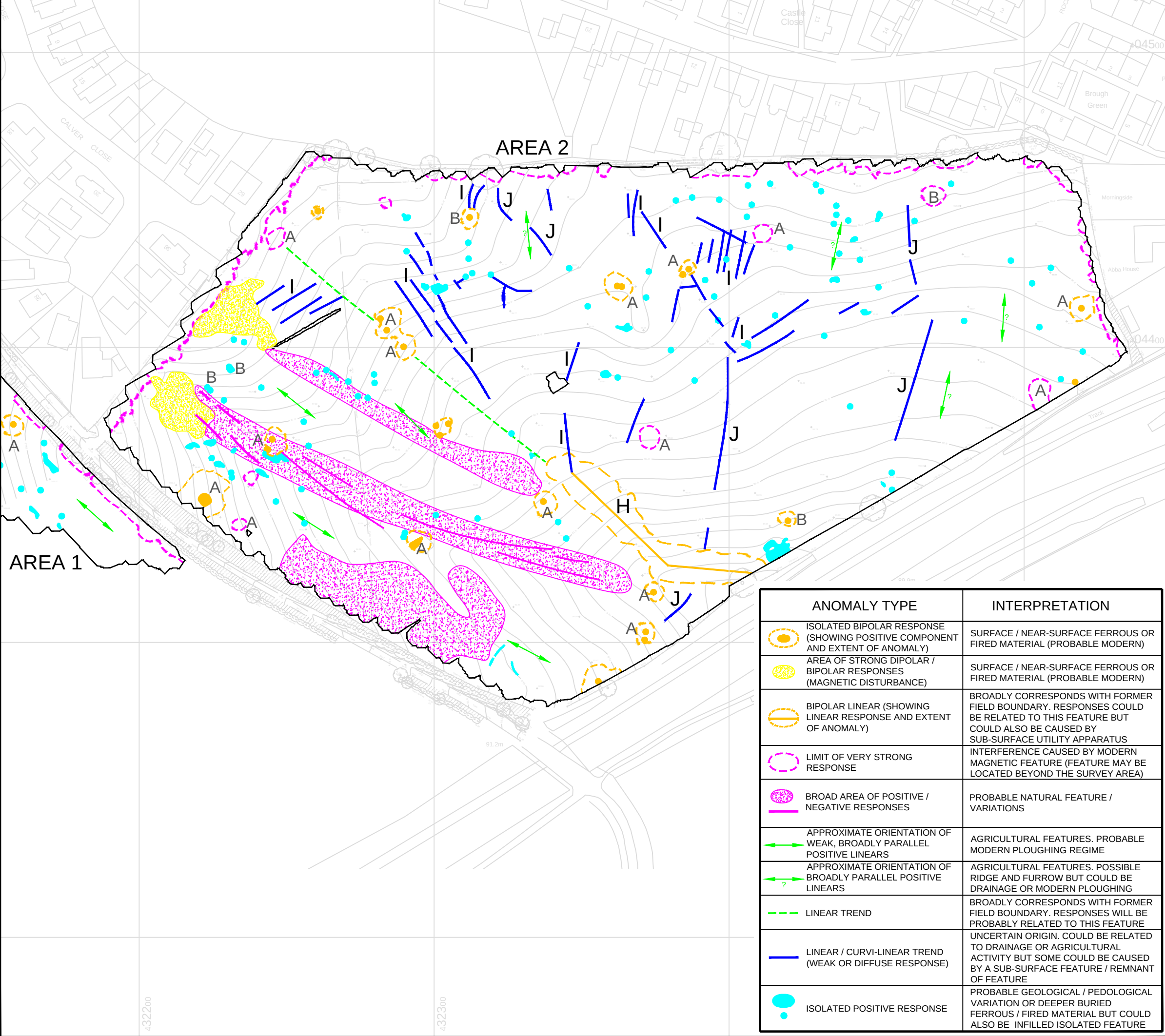


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Scale	[A3 Sheet]	Drawing	Status
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Client	AVANT HOMES YORKSHIRE WAKEFIELD		
Site	SMITHY WOOD LANE DODWORTH, SOUTH YORKSHIRE		
Title	INTERPRETATION OF MAGNETIC GRADIENT DATA: AREA 2 AND PART OF AREA 1		
Job No	ARC_3067_1154		
Surveyed	AM, SBC, PW	Drawn	MW, JW
Chk.	NF	Date	25/03/2021



ANOMALY TYPE	INTERPRETATION
ISOLATED BIPOLAR RESPONSE (SHOWING POSITIVE COMPONENT AND EXTENT OF ANOMALY)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
AREA OF STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE)	SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN)
BIPOLAR LINEAR (SHOWING LINEAR RESPONSE AND EXTENT OF ANOMALY)	BROADLY CORRESPONDS WITH FORMER FIELD BOUNDARY. RESPONSES COULD BE RELATED TO THIS FEATURE BUT COULD ALSO BE CAUSED BY SUB-SURFACE UTILITY APPARATUS
LIMIT OF VERY STRONG RESPONSE	INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA)
BROAD AREA OF POSITIVE / NEGATIVE RESPONSES	PROBABLE NATURAL FEATURE / VARIATIONS
APPROXIMATE ORIENTATION OF WEAK, BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. PROBABLE MODERN PLOUGHING REGIME
APPROXIMATE ORIENTATION OF BROADLY PARALLEL POSITIVE LINEARS	AGRICULTURAL FEATURES. POSSIBLE RIDGE AND FURROW BUT COULD BE DRAINAGE OR MODERN PLOUGHING
LINEAR TREND	BROADLY CORRESPONDS WITH FORMER FIELD BOUNDARY. RESPONSES WILL BE PROBABLY RELATED TO THIS FEATURE
LINEAR / CURVI-LINEAR TREND (WEAK OR DIFFUSE RESPONSE)	UNCERTAIN ORIGIN. COULD BE RELATED TO DRAINAGE OR AGRICULTURAL ACTIVITY BUT SOME COULD BE CAUSED BY A SUB-SURFACE FEATURE / REMNANT OF FEATURE
ISOLATED POSITIVE RESPONSE	PROBABLE GEOLOGICAL / PEDOLOGICAL VARIATION OR DEEPER BURIED FERROUS / FIRED MATERIAL BUT COULD ALSO BE INFILLED ISOLATED FEATURE

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APPENDIX 1

Magnetic survey: technical information

2.1 Theoretical background

- 1.1.1 Magnetic instruments measure the value of the Earth's magnetic field; the units of which are nanoTeslas (nT). The presence of surface and sub-surface features can cause variations or anomalies in this magnetic field. The strength of the anomaly is dependent on the magnetic properties of a feature and the material that surrounds it. The two magnetic properties that are of most interest are magnetic susceptibility and thermoremanent magnetism.
- 1.1.2 Magnetic susceptibility indicates the amount of ferrous (iron) minerals that are present. These can be redistributed or changed (enhanced) by human activity. If enhanced material subsequently fills in features such as pits or ditches then these can produce localised increases in magnetic responses (anomalies) which can be detected by a magnetic gradiometer even when the features are buried under additional soil cover.
- 1.1.3 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 topsoils, subsoils and rocks 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. Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil may give a negative magnetic response relative to the background level. The strength of magnetic responses that a feature will produce will depend on the background magnetic susceptibility, how rapidly the feature has been infilled, the level and type of human activity in the area and the size and depth of a feature. Not all infilled features can be detected and natural variations can also produce localised positive and negative anomalies.
- 1.1.4 Thermoremanent magnetism indicates the amount of magnetism inherent in an object as a result of heating. Material that has been heated to a high temperature (fired), such as brick, can acquire strong magnetic properties and so although they may not appear to have a high iron content they can produce strong magnetic anomalies
- 1.1.5 The magnetic survey method is highly sensitive to interference from surface and near-surface magnetic 'contaminants'. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult, or even impossible, in the vicinity of surface magnetic features. The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.
- 1.1.6 The interpretation of magnetic anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. The main factors that may limit whether a feature can be detected are the

composition of a feature, its depth and size and the surrounding material. It is not possible to guarantee that a magnetic survey will identify all sub-surface features.

- 1.1.7 Most high resolution, near surface magnetic surveys utilise a magnetic gradiometer. A gradiometer is a hand-held instrument that consists of two magnetic sensors, one positioned directly above the other, which allows measurement of the magnetic gradient component of the magnetic field. A gradiometer configuration eliminates the need for applying corrections due to natural variations in the overall field strength that occur during the course of a day but it only measures relative variations in the local magnetic field and so comparison of absolute values between sites is not possible.
- 1.1.8 Features that are commonly located using magnetic surveys include archaeological ditches and pits, buried structures or foundations, mineshafts, unexploded ordnance, metallic pipes and cables, buried piles and pile caps. The technique can also be used for geological mapping; particularly the location of igneous intrusions.

1.2 Instrumentation

- 1.2.1 A multi-sensor array cart system (MACS) utilising 8 Foerster 4.032 Ferex CON 650 gradiometers, spaced at 0.5 m intervals, with a control unit and data logger was used for the magnetic survey.

1.3 Survey methodology

- 1.3.1 The MACS utilises an RTK GNSS system which means that survey grids do not have to be established. Instead, an area is surveyed over a series of continuous profiles and the position of each data point is recorded using an RTK GNSS system. The sensors have a separation of 0.5 m which means that data was collected on profiles spaced at 0.5 m apart. Readings were taken at between 0.1 m and 0.15 m intervals.
- 1.3.2 Data is collected on zig-zag profiles along the full length or width of a field, although fields can be sub-divided if they are particularly large. Marker canes are set-out along field boundaries at set intervals and these are used to align the profiles. The survey profiles are usually offset from field boundaries, buildings and other metallic features by several metres to reduce the detrimental effect that these surface magnetic features have on the data. The location of the MACS data is converted direct to Ordnance Survey co-ordinates using the UK OSTN 02 projection. As the data is related direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.
- 1.3.3 The Foerster gradiometers have a resolution of 0.2 nT but the stability of the cart system significantly reduces noise caused by instrument tilt and movement when compared with a traditional hand-held gradiometer system and the increased data intervals provide a higher resolution data set. The sensors have a range of $\pm 10,000$ nT and readings are taken at 0.1 nT resolution.

1.4 Data processing and presentation

- 1.4.1 The MACS data is stored direct to a laptop using in-house software which automatically corrects for instrument drift and calculates a mean value for each profile. A positional value is assigned to each data point based on the sensor number and recorded GNSS co-ordinates. The data is gridded using in-house software and parameters are set based on the sensor spacing and mean values. No additional processing is required. The gridded data is then displayed in Surfer 9 (Golden Software) and image files of the data are created.

- 1.4.2 The data was exported as raster images (PNG files). A greyscale plot is presented at a clip of -2 nT to 3 nT in drawing ARC_3067_1154_02 (scale 1:2000) and a greyscale plot with an accompanying interpretation at a clip of -5 nT to 5 nT in drawings ARC_3067_1154_03 through ARC_3067_1154_06 (scale 1:1250). Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated. The two different ranges that the data has been displayed at show that the magnetic disturbance, although present across the majority of the site, is less noticeable in the wider range (-5 nT to 5 nT). This indicates that much of the magnetic disturbance is probably caused by relatively small surface / near surface material.
- 1.4.3 The data has been displayed relative to a digital base plan provided by the client as drawing 'SWL-BWB-00-ZZ-M2-G-001_Existing_Site_2D_Mode.dwg.dwg'. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids / data were referenced directly to National Grid co-ordinates the data could be simply superimposed onto the base plan in the correct position.

1.5 Interpretation

- 1.5.1 The anomalies have been categorised based on the type of response that they have and an interpretation as to the cause(s) or possible cause(s) of each anomaly type is also provided. The following anomaly types may be present within the data:

Dipolar, bipolar and strong responses

Dipolar and bipolar responses are those that have a sharp variation between strongly positive and negative components.

In the majority of cases these responses are usually caused by modern ferrous features / objects, although fired material (such as brick), some ferrous or industrial archaeological features and strongly magnetic gravel could also produce dipolar and bipolar responses.

Isolated dipolar responses are those that have a single positive and negative element. They are usually caused by isolated, ferrous or fired material on or near to the surface. The objects that cause dipolar responses are usually relatively small, such as spent shotgun cartridges, iron nails and horseshoes (hence they are often referred to as 'iron spikes') or pieces of modern brick or pot. Some types of archaeological artefacts can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Bipolar anomalies have strong positive and negative components but are not technically magnetic dipoles. The majority of **isolated bipolar responses** are caused by ferrous or fired material on or near to the surface. These responses tend to be produced from larger objects, compared to dipolar anomalies, or a concentration of smaller objects. Some archaeological features/ activity, including areas of burning or industrial activity can also produce this type of response but unless there is strong supporting evidence to the contrary they are assumed not to be of archaeological significance.

Smaller isolated dipolar and bipolar responses have not been shown on the interpretation as there is no evidence to suggest that they are related to archaeological activity. Several larger isolated bipolar responses have been shown as these could be associated with more significant sub-surface features or material (although in this instance they are not thought to be of archaeological interest).

Bipolar linear anomalies are usually produced by buried pipes / cables that are usually metallic, although in some instances ceramic pipes can also produce popular anomalies. In



some instances the anomaly can extend for a significant distance beyond the feature that produces the anomaly. Bipolar anomalies are often very strong and can potentially mask responses from other sub-surface features in the vicinity of the pipe or cable.

In this instance a bipolar linear anomaly is related to a former field boundary.

Areas containing numerous **strong dipolar / bipolar responses (magnetic disturbance)** are usually caused by greater concentrations of ferrous or fired material and are often found adjacent to field boundaries where such material tends to accumulate. Above ground metallic or strongly magnetic features, such as fences, gates, pylons and buildings can also produce very strong bipolar responses. If an area of magnetic disturbance is located away from existing field boundaries then it could indicate a former field boundary, several large isolated objects in close proximity, an area where modern material has been tipped or an infilled cut feature, such as a quarry pit. Areas of dipolar / bipolar response can occasionally be caused by features / material associated with archaeological industrial activity or natural deposits that have varying magnetic properties but they are usually caused by modern activity. Responses in areas of magnetic disturbance can sometimes be so strong that archaeological features located beneath them may not be detected.

Very strong responses, notably bipolar anomalies, from modern features can dominate the data for a significant distance beyond the feature. The extent of these areas is usually shown either as part of the bipolar anomaly or as a **limit of very strong response**. It should be noted that this effect extends beyond the feature and so the limit of the response does not correspond to the actual size or location of the feature within it. In many cases where these strong responses are present at the edge of survey area the feature causing the anomaly be actually be located beyond the survey area. It should be recognised that other sub-surface features located within these areas may not be detected.

Negative linear / curvi-linear anomalies

Negative linear / curvi-linear anomalies occur when a feature has lower magnetic readings than the surrounding material and can often be associated with ploughing regimes or plastic / concrete pipes or natural features.

They can also indicate the presence of a feature that cuts into magnetic soils or bedrock and which is infilled with less magnetic material and in certain geologies can be associated with archaeological features.

Any negative linear anomalies in this data set are thought to relate to agricultural or other relatively modern activity.

Linear / curvi-linear anomalies (probable agricultural)

In many geological / pedological conditions agricultural features / regimes can produce magnetic anomalies due to the accumulation / alignment of magnetic topsoil. In most cases these are exhibited as a series of **broadly parallel positive linear** anomalies. The majority of these responses are associated with modern ploughing regimes but in some instances, where the responses are broader and more widely spaced, they can indicate the presence of the remnants of ridge and furrow.

Field drain systems can also produce linear anomalies, usually where the drains are made from fired ceramic or infilled with magnetic gravels.



Where a series of parallel anomalies are present then the approximate orientation of the anomalies are shown on the interpretation drawing to indicate the direction of the agricultural regime but for the sake of clarity individual anomalies have not been shown.

Individual anomalies may be shown if the response is not part of a regime.

Broad area of positive / negative responses

Broad areas of positive / negative responses can have a variety of causes. If the areas are generally quite large and irregular in shape then they are usually suggestive of natural features, such as lenses of sand and gravel deposits, palaeochannels or other natural features / variations where the natural material differs from the surrounding sub-surface. In some instances anomalies of this type can be associated with anthropogenic (usually modern) activity.

Linear / curvi-linear trends

An anomaly is categorised as a **trend** if it is not certain that the response is associated with an extant sub-surface feature. Trends are usually weak, irregular, diffuse or discontinuous and it is usually not certain what their cause is, if they represent significant sub-surface features or even if they are associated with definite features.

It is possible that some of the trends are associated with geological / pedological variations. Others may be produced by artificial constructs within the data, either caused by processing or in some instances by intersecting anomalies (usually different agricultural regimes) that give the appearance of curving or regular shapes. Many trends are a product of weak, naturally occurring responses that happen to form a regular pattern but which are not associated with a sub-surface feature.

In some instances former features that have been severely truncated can still produce broad, diffuse or weak responses even if the underlying feature has been removed. This is due to the presence of magnetic soils associated with the former feature still being present along its route. In other instances the magnetic properties of the soils filling a feature may vary and so the magnetic signature of the feature can change, even if the sub-surface feature itself remains uniform. If a response from a feature becomes significantly weak or diffuse then part of the anomaly may be shown as a trend as it is uncertain if the feature is still present or has been severely truncated or removed.

Isolated positive responses

Isolated positive responses can occur if the magnetism of a feature, area or material has been enhanced or if a feature is naturally more magnetic than the surrounding material. It is often difficult to determine which of these factors causes any given responses and so the origin of this type of anomaly can be difficult to determine. They can have a variety of causes including geological variations, infilled archaeological features, areas of burning (including hearths), industrial archaeological features, such as kilns, or deeper buried ferrous material and modern fired material.

The large number of isolated responses and lack of an obvious pattern to their distribution suggests that these anomalies are probably associated with geological / pedological variations or deeper buried ferrous or fired material.

Positive linear / curvi-linear anomalies

Positive magnetic anomalies indicate an increase in magnetism and if the resulting anomaly is linear or curvi-linear then this can indicate the presence of a man-made feature.

Positive or enhanced linear / curvi-linear anomalies can be associated with agricultural activity, drainage features but they can also be caused by ditches that are infilled with magnetically enhanced material and as such can indicate the presence of archaeological features. Some natural infilled features can also produce positive anomalies.

- 2.5.2 Several different ranges of data were used in the interpretation to ensure that the maximum information possible is obtained from the data.
- 1.5.3 X-Y trace plots were examined for all of the data and overlain onto the greyscale plot to assist in the interpretation, primarily to help identify dipolar / bipolar responses that will probably be associated with surface / near-surface iron objects. X-Y trace plots have not been used in the report as they do not show any additional anomalies that are not visible in the greyscale data. A digital drawing showing the X-Y trace plot overlain on the greyscale plot has been provided in the digital archive.
- 1.5.4 All isolated responses have been assessed using a combination of greyscale and X-Y trace plots.
- 1.5.5 Anomalies associated with agricultural regimes are present in the data. The general orientation of these regimes has been shown on the interpretation but, for the sake of clarity, each individual anomaly has not been shown.
- 1.5.6 The greyscale plots and the accompanying interpretations of the anomalies identified in the magnetic data are presented as 2D AutoCAD drawings. The interpretation is made based on the type, size, strength and morphology of the anomalies, coupled with the available information on the site conditions. Each type of anomaly is displayed in separate, easily identifiable layers annotated as appropriate.

1.6 Limitations of magnetic surveys

- 1.6.1 The magnetic survey method requires the operator to walk over the site at a constant walking pace whilst holding the instrument. The presence of an uneven ground surface, dense, high or mature vegetation or surface obstructions may mean that some areas cannot be surveyed.
- 1.6.2 The depth at which features can be detected will vary depending on their composition, size, the surrounding material and the type of magnetometer used for the survey. In good conditions large, magnetic targets, such as buried drums or tanks can be located at depths of more than 4 m. Smaller targets, such as buried foundations or archaeological features can be located at depths of between 1 m and 2 m.
- 1.6.3 A magnetic survey is highly sensitive to interference from surface and near-surface magnetic 'contaminants'. Surface features such as metallic fencing, reinforced concrete, buildings or walls all have very strong magnetic signatures that can dominate readings collected adjacent to them. Identification of anomalies caused by sub-surface features is therefore more difficult or even not possible in the vicinity of surface and near-surface magnetic features.
- 1.6.4 The presence of made ground also has a detrimental effect on the magnetic data quality as this usually contains magnetic material in the form of metallic scrap and brick. Identification of features beneath made ground is still possible if the target feature is reasonably large and has a strong magnetic response but smaller features or magnetically weak features are unlikely to be identified.
- 1.6.5 It should be noted that anomalies that are interpreted as modern in origin may 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.

- 1.6.6 A magnetic survey does not directly locate sub-surface features - it identifies variations or anomalies in the local magnetic field caused by features. It can be possible to interpret the cause of anomalies based on the size, shape and strength of response but it should be recognised that a magnetic survey produces a plan of magnetic variations and not a plan of all sub-surface features. Interpretation of the anomalies is often subjective and it is rarely possible to identify the cause of all magnetic anomalies. Geological or pedological (soil) variations or features can produce responses similar to those caused by man-made (anthropogenic) features.
- 1.6.7 Anomalies identified by a magnetic survey are located in plan. It is not usually possible to obtain reliable depth information on the features that cause the anomalies.
- 1.6.8 Not all features will produce a measurable magnetic response and the effectiveness of a magnetic survey is also dependant on the site-specific conditions. It is not possible to guarantee that a magnetic survey will identify all sub-surface features. A magnetic survey is often most-effective at identifying sub-surface features when used in conjunction with other complementary geophysical techniques.



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