# Inglewhite Road, Longridge
# Lancashire

## Archaeological geophysical survey

**Project No. ARC/2881/1086**

**July 2020**

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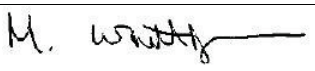
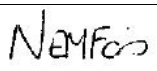
| Signature |  | Signature |  |
| Date | 31/07/20 | Date | 31/07/20 |

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# 1. SUMMARY

Phase Site Investigations Ltd was commissioned to carry out a magnetic gradient survey at Inglewhite Road, Longridge, Lancashire. 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 but there are a number of weak responses of uncertain origin.

The modern material / objects have produced very strong responses or magnetic disturbance that dominates the surrounding data, notably in the east and west of the site. It should be recognised that the strength of the strong responses could mask anomalies from other sub-surface features in those areas, should any such features be present.

There are several weak trends visible in the data, two of which run broadly parallel to each other. Some of the trends have responses that are similar to those produced by field drains and these anomalies could be related to drainage features, however, their exact cause is not certain and they could be related to the remains of other types of structures or features. As the causes of these trends cannot be determined with certainty and, given that a Roman Road is suspected to run in close proximity to, or possibly within the site, an archaeological cause for some of the anomalies cannot be ruled out. A number of other weak trends are present and again the cause of these is not certain but they are more suggestive of former agricultural activity, or possibly be a product of data collection.

# 2. INTRODUCTION

## 2.1 Overview

Phase Site Investigations Ltd was commissioned by Greenlane Archaeology Ltd to carry out an archaeological geophysical survey at Inglewhite Road, Longridge, Lancashire 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 location of the site is shown in drawing ARC_2881_1086_01.

## 2.2 Site description

The site is situated on the north western edge of Longridge (centred at NGR SD 596 381), approximately 10 km to the north east of Preston and covered an area of approximately 0.5 ha.

The site consisted of a single field which had recently been stripped of topsoil. The topography was generally level, except for a raised track along the southern edge and a bank / uneven ground. The ground was firm underfoot in places but other areas, notably in the north-west were waterlogged and very muddy. A number of metal containers and some spoil heaps were present in the west of the area and scattered building rubble and smaller spoil heaps were located across the site. The site was bounded by a hedge in the north and west, a road in the south, and a wooden fence in the east.

The geology of the site consists of mudstone of the Hodder Mudstone Formation overlain by glacial till (British Geological Survey, 2020). The soils of the site are described as slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils (Soilscapes, 2020).

## 2.3 Archaeological background

A full archaeological desk-based assessment was not available at the time of writing this report.

Information in a written scheme of investigation for archaeological trial trench evaluation (Dalcour Maclaren, 2020) indicates that the site is located in an area of a potential Roman road. It states that,

*'The Lancashire HER records a Roman road (PRN39629) that is thought to run adjacent to the south of the Site. Recent LiDAR data has shown an alternative route to the Roman road from Ribchester to Lancaster and although this route has not been proven archaeologically, the projected route potentially places the Roman road within the south eastern boundary of the Site'.*

This is also evidence for archaeological activity from other periods in the wider area.

Historic maps (Dalcour Maclaren, 2020) indicate that the site has been in use for agriculture since before 1885.

## 2.4 Scope of work

The survey area was specified by the client based on a proposed development boundary.

Due to the presence of waterlogged ground, spoil heaps, uneven ground and metal containers the area accessible / suitable for survey was reduced to approximately 0.35 ha, the extents of which are shown in drawing ARC_2881_1086_02.

No other problems were encountered during the survey which was carried out on 15 July 2020.

# 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.

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.

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 survey is referenced direct to Ordnance Survey National Grid co-ordinates temporary survey stations are not established.

## 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 was exported as greyscale raster images (PNG files) and is shown with an accompanying interpretation at a scale of 1:500. All greyscale plots were clipped at -2 nT to 3 nT. Greyscale plots have been 'smoothed' using a visual interpolation but the data itself has not been interpolated.

The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *'Promap-904006-1001769-720-0.dxf'*. 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 have not been shown in the interpretation.

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. 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 very good allowing the data to be viewed at a narrow range of readings to better identify weak anomalies. There are several areas that have strong magnetic responses related to above ground modern features / material and a more disturbed magnetic background but this is due to the presence of magnetic material on the surface or in the sub-surface, rather than low data quality.

The magnetic background data, where there are not any strong / disturbed responses is noticeably uniform. This will be a product of the site having been stripped which has removed the stronger and often more magnetically variable topsoil).

The categories of anomaly, and their possible causes, which have been identified by the survey are discussed in detail below.

## 4.2 Anomaly types and further discussion

There are a number of **isolated dipolar** responses (iron spikes) across the survey area. These contain a strong positive and negative component and are indicative of ferrous or fired material on or near to the surface. **Isolated bipolar** responses are also present. These have strong positive and negative components but are not technically magnetic dipoles. They tend to be caused by ferrous or fired material on or near to the surface and are usually produced from larger, or more strongly magnetic, objects (compared to dipolar anomalies) or a concentration of strongly magnetic smaller objects. In the large majority of cases these two types of isolated responses will be caused by modern material, although in some instances responses of this type can be associated with archaeological features / material. At this site it is thought that all of the dipolar and bipolar responses are caused by modern material and as such they have not been shown on the interpretation.

Areas of **magnetic disturbance** are present. These are areas of strong bipolar and dipolar responses and are usually associated with concentrations of relatively modern magnetic material. In this case they are not considered to be archaeologically significant. The strength of the responses in the west of the area suggests the presence of a significant amount or concentration of modern material.

The very strong responses around the perimeter of the survey area are associated with adjacent strongly magnetic modern features. The extent of these areas is usually shown 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.

Several weak linear **trends** have been identified. Trends are weak and / diffuse responses that may form a regular, linear or curving pattern, but are often too weak and short to reliably interpret. In many instances, where they do not form any obvious patterns or relationships that would suggest they are associated with sub-surface features, they are usually a product of natural features / variations or agricultural activity.

Two of the trends (**Anomalies A**) are broadly parallel to each other and are approximately 6.5 m apart. The responses are suggestive of features such as field drains but they could also be caused by the remains of other types of structures or linear features and unfortunately they are too weak and fragmented to reliably interpret. In the east of the site there are two other weak, short trends (**Anomalies B**) which have similar responses to Anomalies A. These

trends are also suggestive of drainage features but again it is not possible to provide a more definite interpretation and they could be caused by different types of feature(s). **Anomalies C** in the west of the area form a suggestion of an alignment but are too weak to determine if they are caused by a sub-surface feature or are related to former agricultural activity. Anomaly D is broadly aligned with the orientation that the data was collected and could be related to this or to former agricultural activity.

Several **isolated positive responses** are present. This type of anomaly can have a variety of causes including natural features / variations, deeper buried ferrous or fired material, accumulations of topsoil related to agricultural activity, infilled features or areas of burning. The responses at this site are suggestive of modern material and they are not thought to be archaeological significant.

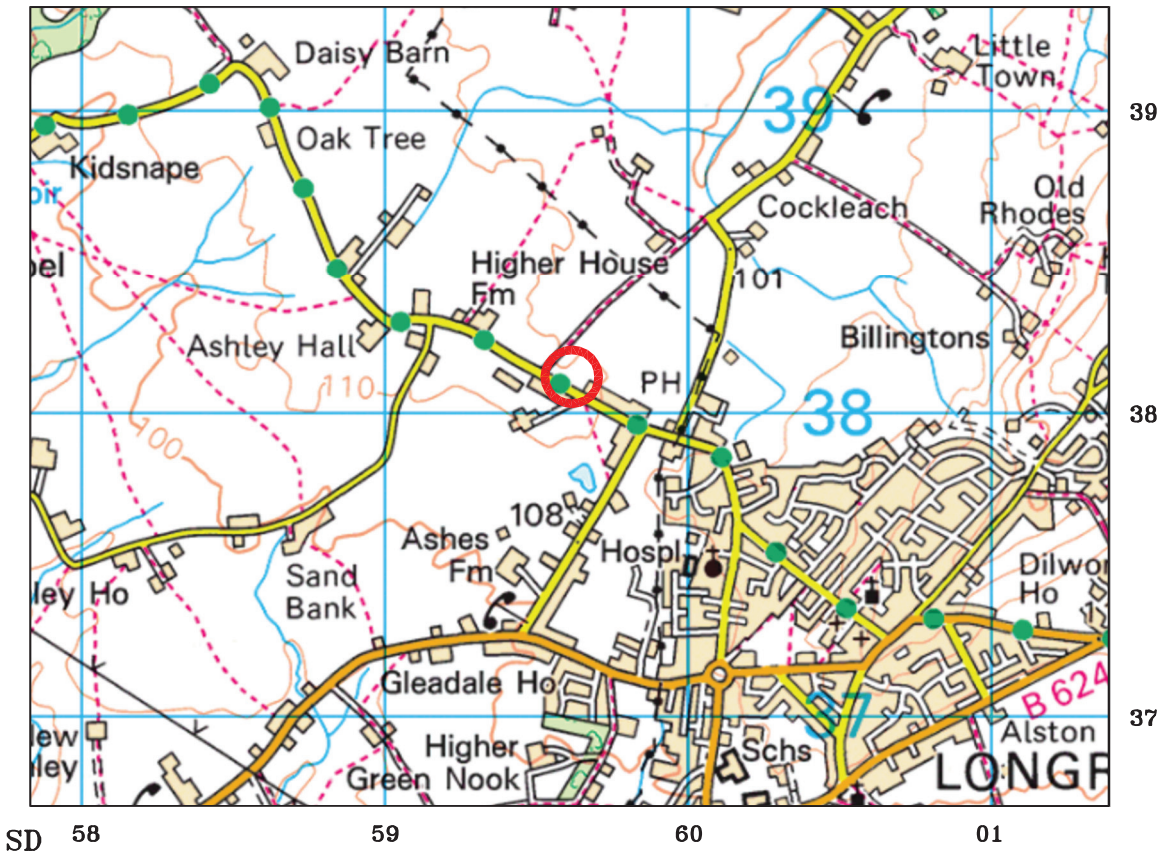
# 5. DISCUSSION AND CONCLUSIONS

The majority of the anomalies identified by this survey relate to modern material / objects but there are a number of weak responses of uncertain origin.

The modern material / objects have produced very strong responses or magnetic disturbance that dominates the surrounding data, notably in the east and west of the site. It should be recognised that the strength of the strong responses could mask anomalies from other sub-surface features in those areas, should any such features be present.

There are several weak trends visible in the data, two of which run broadly parallel to each other. Some of the trends have responses that are similar to those produced by field drains and these anomalies could be related to drainage features, however, their exact cause is not certain and they could be related to the remains of other types of structures or features. As the causes of these trends cannot be determined with certainty and, given that a Roman Road is suspected to run in close proximity to, or possibly within the site, an archaeological cause for some of the anomalies cannot be ruled out. A number of other weak trends are present and again the cause of these is not certain but they are more suggestive of former agricultural activity, or possibly be a product of data collection.

***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***.




SITE LOCATION

SCALE

0m 500m 1000m

NOTE

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| Scale [A4 Sheet] | Drawing | Status |
|---|---|---|
| AS SHOWN | ARC_2881_1086_01 | FINAL |

Client: GREENLANE ARCHAEOLOGY LTD ULVERSTON

Site: INGLEWHITE ROAD, LONGRIDGE LANCASHIRE

Title: SITE LOCATION MAP

Job No: ARC_2881_1086

| | | Drawn | CA |
|---|---|---|---|
| Chk. | MW | Date | 16/07/2020 |




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## KEY

SITE BOUNDARY

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| Scale [A3 Sheet] | Drawing | Status |
|---|---|---|
| 1:500 | ARC_2881_1086_02 | FINAL |

Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

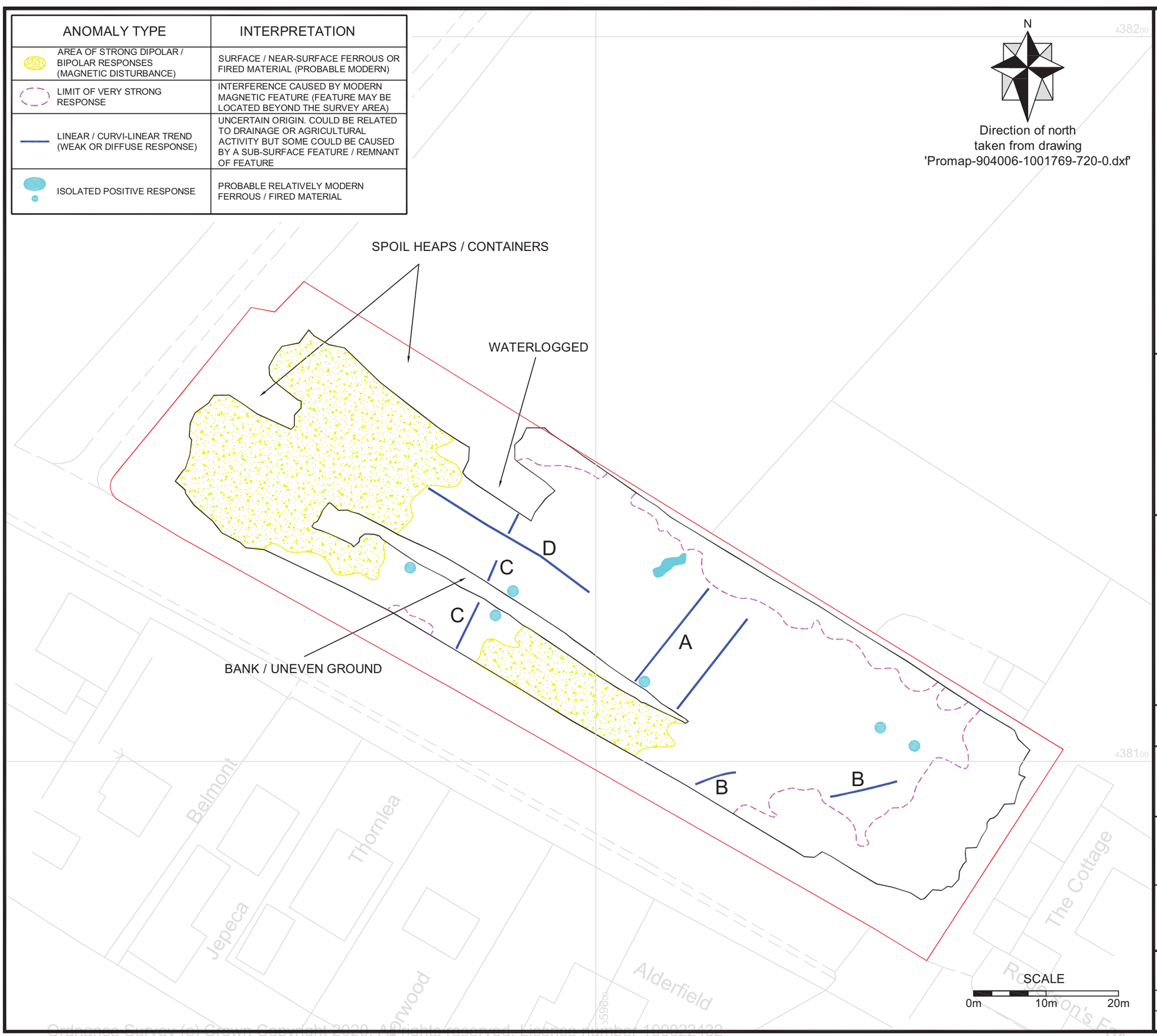
Site
INGLEWHITE ROAD, LONGRIDGE
LANCASHIRE

Title
LOCATION OF SITE SHOWING MAGNETIC GRADIENT DATA

Job No
ARC_2881_1086

| Surveyed | CA | Drawn | CA, MW |
|---|---|---|---|
| Chk. | NF | Date | 15/07/2020 |

| ANOMALY TYPE | INTERPRETATION |
|---|---|
| AREA OF STRONG DIPOLAR / BIPOLAR RESPONSES (MAGNETIC DISTURBANCE) | SURFACE / NEAR-SURFACE FERROUS OR FIRED MATERIAL (PROBABLE MODERN) |
| LIMIT OF VERY STRONG RESPONSE | INTERFERENCE CAUSED BY MODERN MAGNETIC FEATURE (FEATURE MAY BE LOCATED BEYOND THE SURVEY AREA) |
| 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 RELATIVELY MODERN FERROUS / FIRED MATERIAL |




N

Direction of north
taken from drawing
'Promap-904006-1001769-720-0.dxf'



## NOTES

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| Scale [A3 Sheet] | Drawing | Status |
|---|---|---|
| 1:500 | ARC_2881_1086_03 | FINAL |

Client
GREENLANE ARCHAEOLOGY LTD
ULVERSTON

Site
INGLEWHITE ROAD, LONGRIDGE
LANCASHIRE

Title
INTERPRETATION OF
MAGNETIC GRADIENT DATA

Job No
ARC_2881_1086

| Surveyed | CA | Drawn | CA, MW |
|---|---|---|---|
| Chk. | NF | Date | 15/07/2020 |

# BIBLIOGRAPHY AND REFERENCES

British Geological Survey, 2020, online resource - www.bgs.ac.uk

Dalcour Maclaren, 2020, Inglewhite Road, Longridge, Written Scheme of Investigations for Archaeological Trial Trench Evaluation

Soilscapes, 2020, online resource - www.landis.org.uk/soilscapes

# APPENDIX 1

## Magnetic survey: technical information

### 1.1 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 thermoremnant 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 Thermoremnant 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 ± 10,000nT 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 Where required the data was destriped and destaggered to remove errors caused by instrument drift and heading errors. This data has been classed as minimally processed data as no other processing steps were used.

1.4.3 The data was exported as raster images (PNG files), and are presented in greyscale format at 1:500.

1.4.4 The data has been displayed relative to a digital Ordnance Survey base plan provided by the client as drawing *'Promap-904006-1001769-720-0.dxf'*. The base plan was in the Ordnance Survey National Grid co-ordinate system and as the survey grids were set-out 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.

Isolated dipolar and bipolar responses have not been shown on the interpretation as there is no evidence to suggest that they may be archaeological in origin.

**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 sigfncaint 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.

There are no bipolar linear anomalies in this data set.

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 anomalies

**Negative 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.

There are no significant negative linear anomalies in this data set.

### 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.

There are no anomalies suggestive / indicative of agricultural activity / features in this data set.

### 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.

There are no anomalies of this type in this data set.

### 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. Only the larger or stronger areas of positive response have been shown on the interpretation. The majority, if not all of these responses, will be related to natural variations or relatively modern material but have been shown as their exact cause cannot be determined with certainty.

### 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.

There are no significant positive linear anomalies in this data set.

1.5.2 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 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.