GEOPHYSICAL SURVEY REPORT

Brick Kiln Lane, Mansfield, Nottinghamshire

Client

Orion Heritage

For

Piper Homes (Ladybrook) Ltd

Survey Report

07666

OASIS Ref. No.

sumogeop1-506954

Date

24 May 2022

Survey Report 07666: Brick Kiln Lane, Mansfield, Nottinghamshire

Survey dates	3-4 May 2022
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Report Date	24 May 2022
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3 SURVEY TECHNIQUE

3.1 Detailed magnetic survey (magnetometry) was chosen as the most efficient and effective method of locating the type of archaeological anomalies which might be expected at this site. All survey techniques will follow the guidance set out by CIFA (2014, updated 2020), Historic England (2008), and the European Archaeology Council (EAC) (2016).

Bartington Cart System Traverse Interval 1.0m Sample Interval 0.125m

The only processes performed on data are the following unless specifically stated otherwise:

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes instrument striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

4 SUMMARY OF RESULTS

4.1 A magnetometer survey of 6.8 hectares of land off Brick Kiln Lane, Mansfield has not recorded any magnetic responses that could be interpreted as being of definite archaeological interest. Strong ferrous anomalies in Area 6 could be due to spreads of modern debris or just possibly associated with brick making or coal mining. A single uncertain negative response likely marks the route of a land drain, and several uncertain pit-like anomalies are probably due to deeply buried ferrous debris. A former field boundary, land drains plus ridge and furrow ploughing are visible in the dataset. A modern track has also been detected.

5 INTRODUCTION

5.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey of an area outlined for residential development. This survey forms part of an archaeological investigation being undertaken by **Orion Heritage** on behalf of **Piper Homes (Ladybrook) Ltd.**

5.2 Site Details

NGR / Postcode	SK 51373 61159 / NG19 6LU	
Location	The site is located 3km south of Pleasley and 2km north-east of Sutton-in-Ashfield. The survey area is bounded to the north-east by Brick Kiln Lane, to the north-west by Abbott Road (A6075) and to the east by houses off Petersfield Close.	
HER	Nottinghamshire HER	
OASIS Ref. No.	sumogeop1-506954	
District	Mansfield	
Parish	Non-Civil Parish	
Topography	Generally flat	
Land Use	Pasture	
Geology (BGS 2022)	Bedrock:	Lenton Sandstone Formation - Sandstone
	Superficial:	Glaciofluvial Deposits, Mid Pleistocene - Sand and Gravel
		Till, Mid Pleistocene - Diamicton
Soils (CU 2022)	Soilscape 18: Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	
Survey Methods	Magnetometer survey (fluxgate gradiometer)	
Study Area	6.8 ha	

5.3 ***Archaeological Background*** *(OH 2021)*

5.3.1 A historical environment desk-based assessment has been carried out by Orion Heritage.

5.3.2 A review of the available evidence has confirmed that the study site has a low potential for archaeological remains of all periods, although the lack of archaeological evidence could be a product of the lack of intrusive investigations recorded in the study area.

5.3.3 There are currently no previous phases of occupation identified on the study site but there may be evidence of former agricultural practices. Cropmark features of possible Prehistoric date have been detected to the south and west of the study site, but it lay away from primary settlement at Mansfield and Skegby.

5.3.4 Four dark toned maculae are evident on aerial photography c.80m to the south of the study site (MNT6994). These are thought to be possible postmedieval or modern mine shafts. A larger macula in the area could be plough spread. Mining activity has also been detected c.250m to the south of the study site (MNT7217). Small mounds have been seen further to the south, also indicative of mine shafts (MNT7209). To the north of the study site further mining activity is noted. The possible remains of a bell pit or shaft has been detected c.150m to the north of the study site (MNT6989); larger maculae could be plough spread. Former mining shafts are also indicated to their east (MNT6990). Bell pits can be seen further to the north near Penniment House Farm (MNT6991, MNT 6993).

5.4 *Aims and Objectives*

5.4.1 To locate and characterise any anomalies of possible archaeological interest within the study area.

6 RESULTS

6.1 *The survey has been divided into seven survey areas (Areas 1-7).*

6.2 *Probable / Possible Archaeology*

6.2.1 No magnetic responses have been recorded that could be interpreted as being of definite archaeological interest.

6.3 *Uncertain*

6.3.1 A meandering band of strong magnetic responses in Area 6 is difficult to interpret with confidence. The eastern half has a strong ferrous component with dipolar anomalies apparently concentrated within channels (see XY traces Fig 07 and also the colour plots Fig 03). By contrast the anomalies in the west indicate strong magnetic enhancement without the ferrous component, unless the ferrous material is at much greater depth in this area. The responses might indicate a former metalled trackway linked to the old fishponds in the south or material dredged out of these ponds. The name Brick Kiln Lane does raise the possibility that the responses might be related to such activity. A third possible cause could be that the anomalies are associated with former coal extraction / mining operations; this is recorded in the vicinity as noted in the HER (see 5.3.4 above). Coal mining records (https://mapapps2.bgs.ac.uk/coalauthority/home.html) suggest that such activity could have taken place on the site. Given the lack of specific evidence to support any of the interpretations, the responses are categorised as having an uncertain origin.

6.3.2 A negative linear anomaly is visible in the north of Area 6 and has also been assigned to the category of *Uncertain*. Several land drains have been recorded in the dataset (see 6.5), this response could also mark the location of another land drain. Pit-like responses are probably due to deeply buried ferrous debris but their true origin in unclear.

6.4 *Former Field Boundary – Corroborated*

6.4.1 A linear response has been detected in Area 6 which corresponds to the location of a former field boundary that is recorded on historic mapping (see Figure 05).

6.5 *Agricultural –Land Drains / Ridge and Furrow*

6.5.1 Numerous linear anomalies are visible in Areas 2 and 5 which mark the routes of land drains.

6.5.2 Parallel and broad linear responses have been recorded in Areas 1 and 5 which are due to ridge and furrow ploughing.

6.6 *Track*

6.6.1 A track is visible in Area 6 on aerial imagery (see Figure 05) and a linear response in the data corresponds with its location.

6.7 *Ferrous / Magnetic Disturbance*

6.7.1 Areas of magnetic disturbance are likely to be due to spreads of debris associated with agricultural processes or modern developments. Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

7 DATA APPRAISAL & CONFIDENCE ASSESSMENT

7.1 Historic England guidelines (EH 2008) Table 4 states that the typical magnetic response on the local soils / geology is variable. The results from this survey indicate the presence of former field boundaries plus ridge and furrow ploughing; as a consequence, there is no *a priori* reason why archaeological features would not have been detected. However, weak anomalies of archaeological interest will have been masked by the magnetic disturbance and strong ferrous responses throughout the survey, if present.

8 CONCLUSION

8.1 The magnetometer survey has not recorded any magnetic responses that could be interpreted as being of definite archaeological interest. However, strong amorphous ferrous anomalies in Area 6 have an uncertain origin, and could be due to spreads of modern debris, perhaps be related to brick manufacture (based on place-name evidence) or might indicate mining activity. A negative response and several pit-like anomalies have been detected in the survey and have also been assigned to the category of uncertain. The linear anomaly is likely to mark the location of a land drain while the ostensibly pit-like responses are probably due to deeply buried ferrous debris. A former field boundary, land drains plus ridge and furrow ploughing are visible in the dataset. A modern track has also been detected.

9 REFERENCES

BGS 2022 British Geological Survey, Geology of Britain viewer [accessed 20/05/2022] *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps)

CIfA 2014 Amended 2020 *Standard and Guidance for Archaeological Geophysical Survey.* Amended 2020. CIfA Guidance note. Chartered Institute for Archaeologists, Reading https://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_3.pdf

CU 2022 The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. [accessed 20/05/2022] *website: http://mapapps2.bgs.ac.uk/ukso/home.html*

EAC 2016 *EAC Guidelines for the Use of Geophysics in Archaeology,* European Archaeological Council, Guidelines 2.

EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon (now withdrawn, but used for evaluating suitability of soil types)

OH 2021 *Brick Kiln Lane, Mansfield, Nottinghamshire Archaeological Desk-Based Assessment. Orion Heritage, Manchester*

10 ARCHIVE

10.1 The minimally processed data, data images, XY traces and a copy of this report are stored in **SUMO Geophysics Ltd.'s** digital archive, on an internal RAID configured NAS drive in the Midlands Office. These data are also backed up to the Cloud for off-site storage.

10.2 The Grey Literature will be archived with OASIS and the relevant HER within a period of 12 months.

Survey Areas

N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Site Location

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
NOT TO SCALE

Fig No:
01

N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 80
1:1600 @ A3

Fig No:
02

N

+100nT

-100nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Colour Plots

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 80
1:1600 @ A3

Fig No:
03

N

KEY

	Uncertain Origin (discrete anomaly / trend / hatch)
	Former field boundary (corroborated)
	Track
	Agriculture (ridge and furrow)
	Land drain
	Magnetic disturbance
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

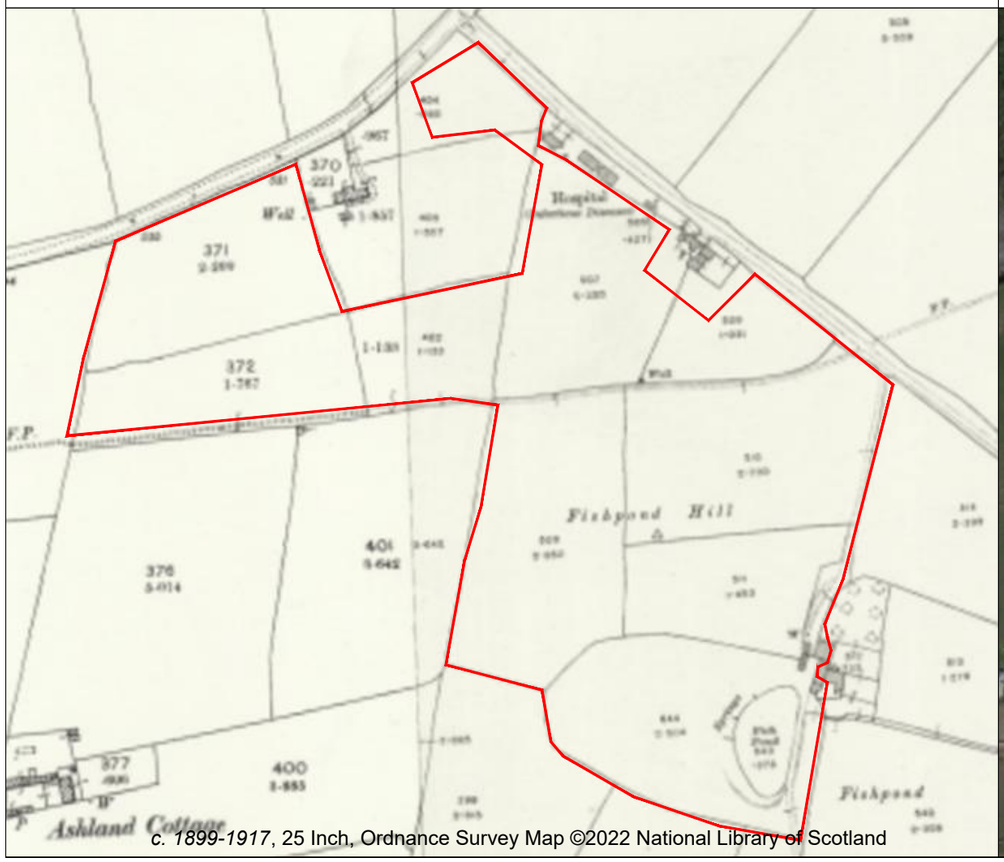
Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 80
1:1600 @ A3

Fig No:
04



c. 1899-1917, 25 Inch, Ordnance Survey Map ©2022 National Library of Scotland

©2022 Google Earth

N

+2nT

-1nT

KEY

	Uncertain Origin (discrete anomaly / trend / hatch)
	Former field boundary (corroborated)
	Track
	Agriculture (ridge and furrow)
	Land drain
	Magnetic disturbance
	Ferrous

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Greyscale Plots / Interpretation / *c.1899-1917* Ordnance Survey Map / 2021 Aerial Image

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 160
1:3200 @ A3

Fig No:
05

N

+10nT

-10nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Minimally Processed Data - Greyscale Plots

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 75
1:1500 @ A3

Fig No:
06

N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
XY Trace Plots (clipped at +/-15nT)

Client:
Orion Heritage

Project:
07666 - Brick Kiln Lane, Mansfield, Nottinghamshire

Scale:
0 metres 80
1:1600 @ A3

Fig No:
07

Appendix A - Technical Information: Magnetometer Survey Method

Grid Positioning

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m
Magnetometer	Bartington Cart System	1.0m	0.125m

Instrumentation:

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted horizontally, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths.

Bartington Grad 601-2

Hand-Held: Data will be collected using a Bartington Grad 601-2. The instrument consists of two paired sensors and readings are logged at 0.25m centres along traverses 1.0m apart across 30m grids. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution as per Historic England guidelines

Bartington Cart System

Data will be collected using a cart carrying four paired Bartington magnetic sensors. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings will be taken at 0.125m centres along traverses 1.0m apart.

Data Processing

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

Display

Greyscale/ Colourscale Plot	This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly, all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Interpretation Categories

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall,* etc.) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

Archaeology / Probable Archaeology	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
Possible Archaeology	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Industrial / Burnt-Fired	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
Former Field Boundary (probable & possible)	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
Ridge & Furrow	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
Agriculture (ploughing)	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Land Drain	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
Magnetic Disturbance	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
Service	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
Ferrous	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
Uncertain Origin	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of *Possible Archaeology* / *Natural* or (in the case of linear responses) *Possible Archaeology* / *Agriculture*; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

Appendix B - Technical Information: Magnetic Theory

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), can be accurately detected.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns; material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

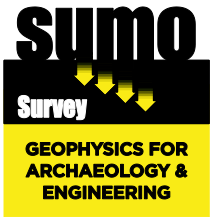
Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried feature. The difference between the two sensors will relate to the strength of a magnetic field created by this feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity and disturbance from modern services.

Summary for sumogeop1-506954

OASIS ID (UID)	sumogeop1-506954
Project Name	Geophysical Survey at Brick Kiln Lane, Mansfield, Nottinghamshire
Sitename	
Activity type	Geophysical Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	07666
Planning Id	
Reason For Investigation	Planning requirement
Organisation Responsible for work	SUMO Geophysics Ltd.
Project Dates	03-May-2022 - 04-May-2022
Location	Brick Kiln Lane, Mansfield, Nottinghamshire NGR : SK 51323 61188 LL : 53.1453686678934, -1.23413848377221 12 Fig : 451323,361188
Administrative Areas	Country : England County : Nottinghamshire District : Mansfield Parish : Mansfield, unparished area
Project Methodology	A temporary grid system was established over the site and marked out using canes. The location of the grid will be set out using an RTK GPS system theoretically accurate to some 0.01m and referenced to OS co-ordinates. Data will be collected using a cart carrying four paired Bartington magnetic sensors. Four sensors mounted 1m horizontally apart and very accurately aligned to nullify the effects of the earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings will be taken at 0.125m centres along traverses 1.0m apart. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. At the end of every data collection a zone of data was recollected as a control.
Project Results	The magnetometer survey has not recorded any magnetic responses that could be interpreted as being of definite archaeological interest. However, strong amorphous ferrous anomalies in Area 6 have an uncertain origin, and could be due to spreads of modern debris, perhaps be related to brick manufacture (based on place-name evidence) or might indicate mining activity. A negative response and several pit-like anomalies have been detected in the survey and have also been assigned to the category of uncertain. The linear anomaly is likely to mark the location of a land drain while the ostensibly pit-like responses are probably due to deeply buried ferrous debris. A former field boundary, land drains plus ridge and furrow ploughing are visible in the dataset. A modern track has also been detected.
Keywords	Field Boundary - POST MEDIEVAL - FISH Thesaurus of Monument Types Drain - 20TH CENTURY - FISH Thesaurus of Monument Types Ridge And Furrow - MEDIEVAL - FISH Thesaurus of Monument Types
Funder	
HER	Nottinghamshire HER - unRev - STANDARD

Person Responsible for work	Thomas, Cockcroft
HER Identifiers	
Archives	



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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