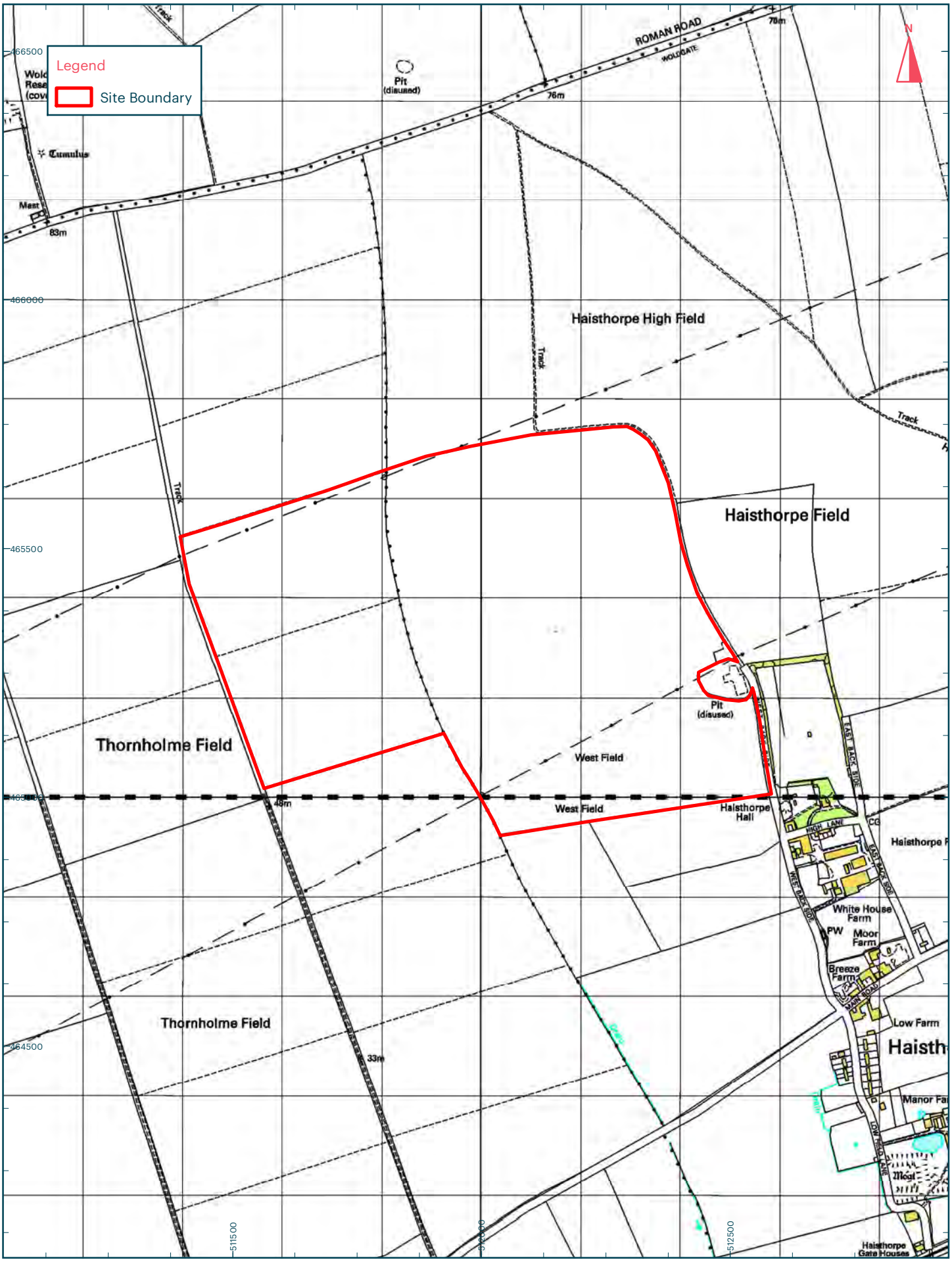

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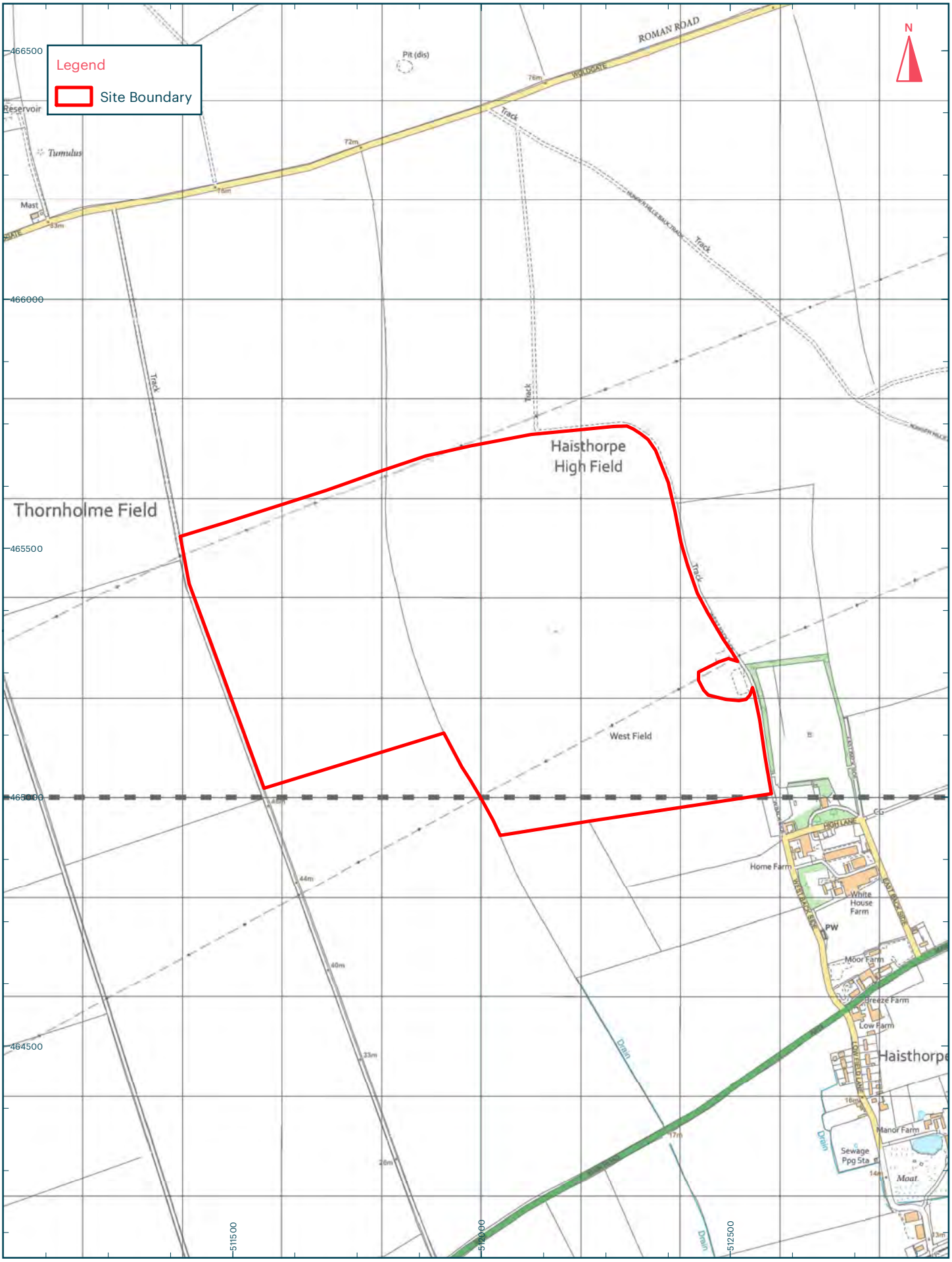
Figure 19: 2006 Ordnance Survey 1:10,000 Map
Address:
Three Oaks Renewable Energy Park

Scale at A4: 1:10,000
0 300m



Title:
Figure 20: 2021 Ordnance Survey 1:10,000 Map
Address:
Three Oaks Renewable Energy Park

Scale at A4: 1:10,000
0 300m

GEOPHYSICAL SURVEY REPORT

Three Oaks Renewable Energy Park
Haisthorpe, East Yorkshire

Client

Orion Heritage Ltd

For

Ridge Clean Energy Ltd

Survey Report

07268

OASIS Ref. No.

sumogeop1-506589

Date

09 May 2022

Survey Report 07268: Three Oaks Renewable Energy Park

Survey dates	23-41 March 2022 1-7 April 2022
Field co-ordinator	Jay Griffiths BA
Field Team	Robert Ottolangui MSc Simon Lobel BSc George Slater BEng
Report Date	09 May 2022
CAD Illustrations	Thomas Cockcroft MSc Liam Brice-Bateman BA
Report Author	Thomas Cockcroft MSc Dr John Gater BSc DSc(Hon) MCIfA FSA
Project Manager	Simon Haddrell BEng AMBCS PCIfA
Report approved	Dr John Gater BSc DSc(Hon) MCIfA FSA

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geophysics@sumoservices.com

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1 LIST OF FIGURES

2 LIST OF APPENDICES

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, now retracted), 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.

4 SUMMARY OF RESULTS

4.1 A magnetometer survey of some 64 hectares of land north-west of Haisthorpe, East Yorkshire, has identified a plethora of magnetic responses which are indicative of a range of archaeological sites and features extending across much of the survey area. The results are interpreted as including an extensive multi-period settlement site; several rectilinear enclosures and fields; a number of possible square and round barrows; lines of large pits or burials; and several roads, droveways or boundary ditches. Additionally, palaeo-landscape features have been identified.

5 INTRODUCTION

5.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey of an area outlined for a proposed solar energy park development. This survey forms part of an archaeological investigation being undertaken by **Orion Heritage Ltd** on behalf of **Ridge Clean Energy Ltd**.

5.2 Site Details

NGR / Postcode	TA 1217 6534 / YO25 4NW
Location	The area under investigation lies some 7km southwest of Bridlington and northwest of Haisthorpe. The A6144 lies to the south of the site, W Back Side Lane forms the eastern boundary and agricultural fields surround the survey area. A former chalk pit lies on the eastern boundary.
HER	East Riding of Yorkshire (EYHER)
OASIS Ref. No.	sumogeop1-506589
District	East Riding of Yorkshire
Parish	Burton Agnes CP (Area 1); Carnaby CP (Area 2)
Topography	Gently sloping from 55m in north to 30m in south
Land Use	Agricultural
Geology (BGS 2022)	Bedrock: Flamborough Chalk Formation - chalk Superficial: Mostly none recorded except for Till, Devensian - diamicton
Soils (CU 2022)	Soilscape 7: freely draining slightly acid but base-rich soils
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	64 ha

5.3 ***Archaeological Background*** (OH 2022)

5.3.1 Two Scheduled Monuments, both barrow burials, lie within 1km of the study site but still some distance away: Sands Wood Round Barrow (NHLE 1017994) is located to the northeast and South Side Mount Round Barrow (NHLE 1005232) is located to the northwest.

5.3.2 In addition to the Scheduled barrows, a third barrow is located approximately 250m northeast of the study site (MHU11760). This is a square barrow identified through aerial photographs. It is associated with a findspot of Neolithic lithics and an axe (MHU15548).

5.3.3 To the west and northwest of the study site, within 500m and extending to the north, cropmarks indicate field systems, enclosures, tracks and ring ditches (MHU 7583 and MHU3261). These are undated but their morphology suggests a Prehistoric origin. The cropmarks are not defined

by investigation and therefore related activity may extend into the study site, though the potential for Prehistoric archaeology is considered to be moderate.

5.3.4 There is no known recorded Roman activity within the study site. To the north, at a distance of approximately 500m, the Woldgate road, is labelled as a Roman road on historic and modern mapping. It is thought to be the link between the city of York and the port at Bridlington. Whilst roadsides in the Roman period were sporadically used for settlement or burial of goods and people, the distance to the study site means that this is unlikely to extend inside the site boundary. Therefore, there is a low potential for the study site to contain finds or features relating to the Roman period.

5.3.5 Haisthorpe is recorded as a shrunken medieval village (MHU10028) and is now located immediately southeast of the study site. Whilst no medieval remains are known within the site, it would have been part of the immediate settlement hinterland with a probable agricultural use and low potential for archaeology.

5.3.6 The site is divided between the 1840 Burton Agnes and Haisthorpe Tithe map and the 1840 Thornholme Tithe map. Both show the site in detail for the first time. It is divided into a series of linear plots with a 'stone pit' on the eastern boundary. The stone pit, also later referred to as a lime kiln or chalk pit, is referenced on the HER as MHU15089.

5.4 *Aims and Objectives*

5.4.1 The above review of the available archaeological evidence has confirmed that the study site has a low potential to contain finds and features relating to the Roman and medieval periods. There is moderate potential for the adjacent Prehistoric cropmarks to extend into the site and for additional post medieval activity relating to the chalk pit and lime kiln to be located within the site boundary. It was anticipated that geophysical survey would provide further information relating to the cropmarks and potential industrial remains.

6 RESULTS

6.1.1 *The survey has been divided into two survey areas (Areas 1-2) and specific anomalies have been given numerical labels [1] [2] which appear in the text below, as well as on the Interpretation Figure(s). The survey has identified numerous magnetic anomalies which are indicative of a range of archaeological features spread across the survey area. For ease of reporting, the features are divided into groups based on anomaly shape or archaeological type*.

6.2 *Probable / Possible Archaeology*

6.2.1 Rings, circles and ovals

[1] A well-defined annular ditch feature measuring *c.*20m x 20m with a break / entrance in SE; no obvious internal features. It partially coincides with, or is overlapped by a second ring or arc of similar dimensions.

[2] A tentative ring ditch some 10m in diameter, though the southern half is poorly defined.

[3] A possible ring ditch 10m in diameter, partially masked by other magnetic anomalies.

[4] A small oval feature 9m x 11m in size with a well-defined internal pit or hearth. The ring may be associated with a linear magnetic response or field system.

[5] Short ditch responses forming a possible segmented oval feature with a potential diameter of 14m; ditch lengths are visible extending from the feature.

[6] A clear ring ditch 10m in diameter;

[7] A cluster of four or five ring responses of varying sizes from 5m to 10m in diameter; they appear to be set within a rectilinear enclosure [15].

6.2.2 'Small' Squares

[8] Three short ditch lengths at the northern edge of Area would appear to form a square feature which extends into the adjacent field; the length of the southern side is *c.*12-13m. There is no obvious anomaly inside the feature; it is possible that the responses indicate a square barrow of Iron Age date.

6.2.3 'Large' Squares and Rectilinear anomalies

[9] A group of linear and rectilinear responses cover an area of about 1 hectare and form a number of regular overlapping enclosures with subdivisions; some appear to contain multiple pits / possible burials. A droveway or trackway [18] forms the southern boundary.

[10] This is an area some 7-8 hectares in size which contains a complex of enclosures of varying sizes; many are interlinked / overlapped and form a regular pattern. Some of the enclosures contain pit-like features while others have no internal features. Others [11 and 12] are irregularly shaped and set apart from the main concentration of enclosures and may be from a different period. The magnetic results are not dissimilar to those found at the important multi-period site of Wharram Percy (EH 2003).

[13] A rectangular enclosure 25m by 35m in size and a length of ditch which extends to the west and possibly to the east.

[14] A rectilinear enclosure measuring 35m by 40m with a break / entrance on the southern ditch; the northern and eastern ditches are less well defined.

[15] A trapezoidal ditched enclosure though the southern side is partially obscured by the modern field boundary; it measures in the order of 60m N-S and 50m E-W. It appears to contain a cluster of ring ditches [see 7] and pits.

6.2.4 Linear anomalies

[16], [17], [18] and [19]. These comprise single or double ditches associated with roads or droveways; these form a crossroads junction at [20].

[19] This road continues southwards, through the settlement [10] and joins with another putative track or field boundary [21].

[22] The linear responses may indicate further tracks or boundaries.

[23] Linear ditches, possibly double ditches in places, form regular enclosures.

6.2.5 Discrete anomalies

[24] Two strong anomalies adjacent to [19] could be roadside burials or pits.

[25] A large rectangular pit-like feature or perhaps extended burial on roadside [18]; the strong magnetic anomaly suggest the feature could be 10m E-W and 5m N-S in size.

[26] A cluster of pit-like anomalies some of which could be associated with burnt or fired features

[27] A line of large pits-like anomalies which follow the field division between Areas 1 and 2; the responses probably indicate burials following a road / track running along this historic Parish boundary.

[28] Another line of pits indicating possible burials similar to those at [27].

6.2.6 A number of weak linear responses have been assigned to the category of Possible Archaeology, while these are not as well defined as other responses in the dataset, archaeological origins cannot be discounted.

6.3 *Uncertain*

6.3.1 It is inevitable that a survey on this large scale will result in a few responses being recorded where it is not possible to differentiate between archaeological, agricultural and natural origins; as a consequence, these are interpreted as having an uncertain origin.

6.4 *Agricultural – Ridge and Furrow / Ploughing / Land Drains*

6.4.1 Parallel linear and slightly curving responses in the data are probably associated with past ridge and furrow cultivation on the site.

6.5 *Geological / Pedological*

6.5.1 The survey contains many zones of amorphous responses which show as a mottled effect in the data image; these coincide with localised variations in the chalk bedrock and are typical of the magnetic responses found on wold landscapes. Additionally, there are very clear palaeochannels; there is a large channel In Area 1 and it is interesting to note how some of the pit / burial responses [28] appear to follow this band. Two of the meanders form a loop in Area 2 and there is an ancient alluvial fan in the north-east. Road or boundary anomaly [28] shadows the western side of the loop. The palaeo-features are clearly visible in the LIDAR imagery.

6.6 *Ferrous / Magnetic Disturbance*

6.6.1 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 good. The results from this survey indicate the presence of a range of anomalies; as a consequence, the technique is deemed to have worked well.

8 CONCLUSION

8.1 The magnetometer survey has recorded a plethora of magnetic responses which are interpreted as being of definite archaeological interest. Ring ditches; possible square and round barrows; large pits and / or burials; trackways and droveways; plus rectilinear enclosures and former field systems are all visible in the data. The results could indicate Bronze Age, Iron Age, Romano-British and Medieval activity on the site. The geophysical results also show former field boundaries, possible ridge and furrow ploughing, plus complex palaeo-landscape features.

9 REFERENCES

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

EH 2003 *Wharram Percy, North Yorkshire: Report on Geophysical Surveys 1984-2002,* Centre for Archaeology Report 28/2003

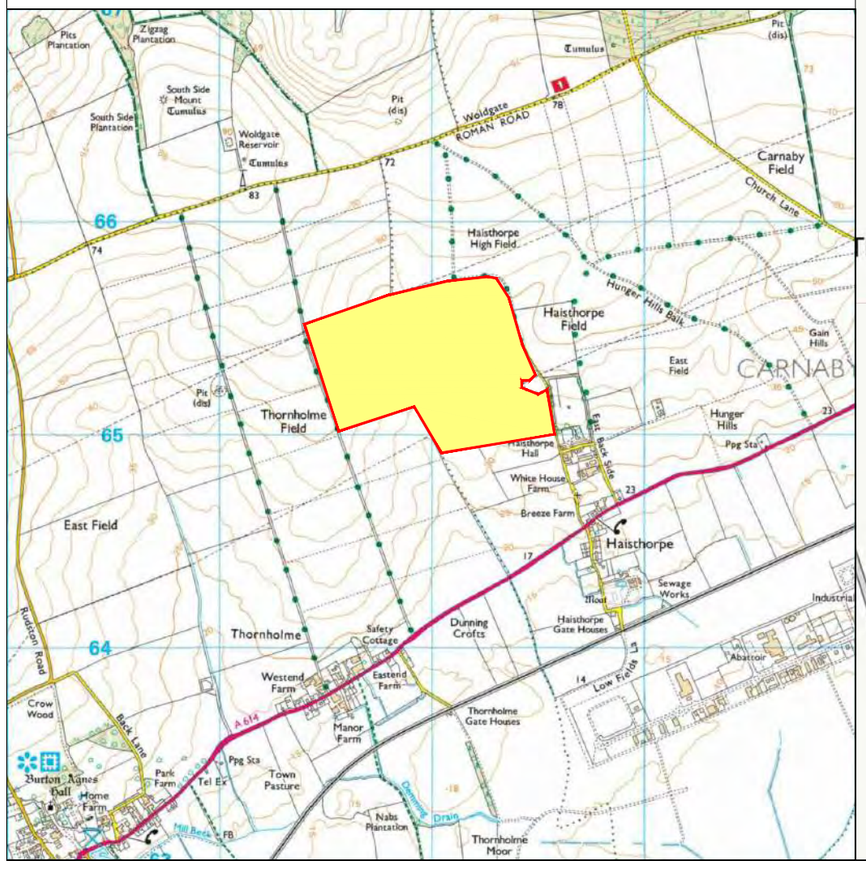
EH 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Swindon (now withdrawn, but used for evaluating suitability of soil types)

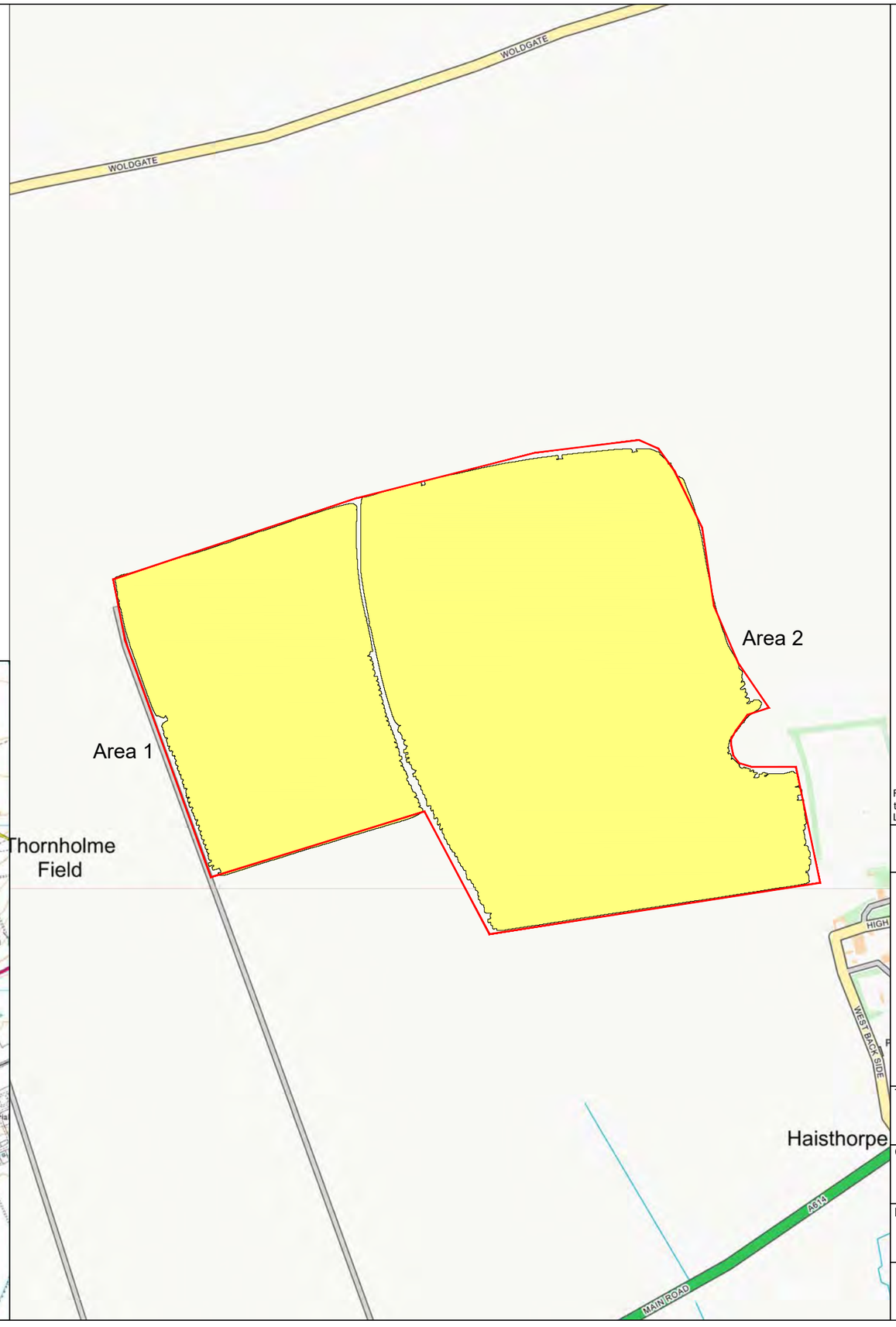
OH 2022 *Three Oaks Renewable Energy Park Historic Environment Desk-Based Assessment (DRAFT). Orion Heritage, Brighton*

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 Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
NOT TO SCALE

Fig No:
01

N

+2nT

-1nT

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 200
1:4000 @ A3

Fig No:
02

N

+100nT

-100nT

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

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Magnetometer Survey - Colour Plots

Client:
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Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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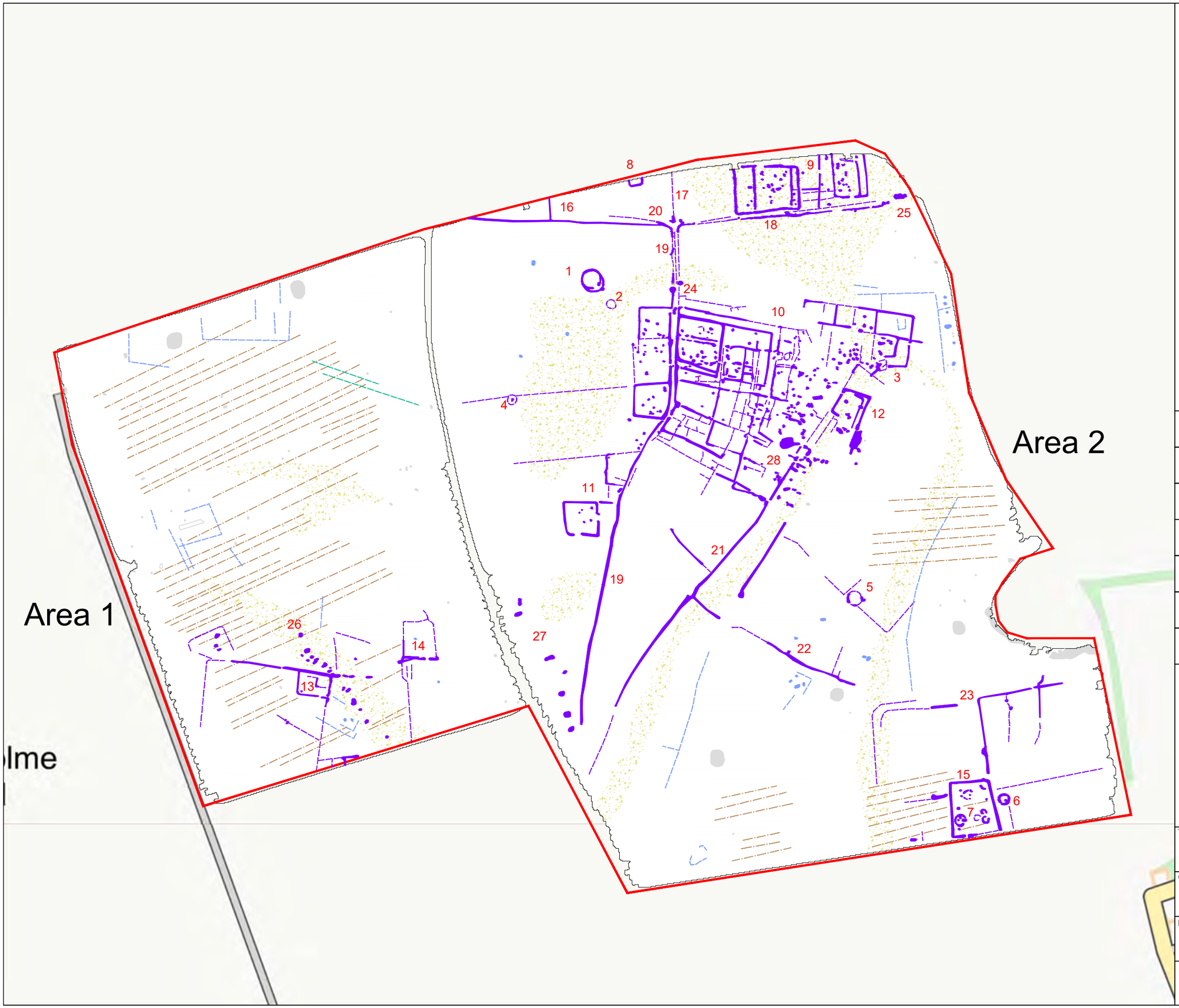

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	Possible archaeology (discrete anomaly / trend)
	Uncertain Origin (trend)
	Agriculture (ridge and furrow)
	Natural (e.g. geological / pedological)
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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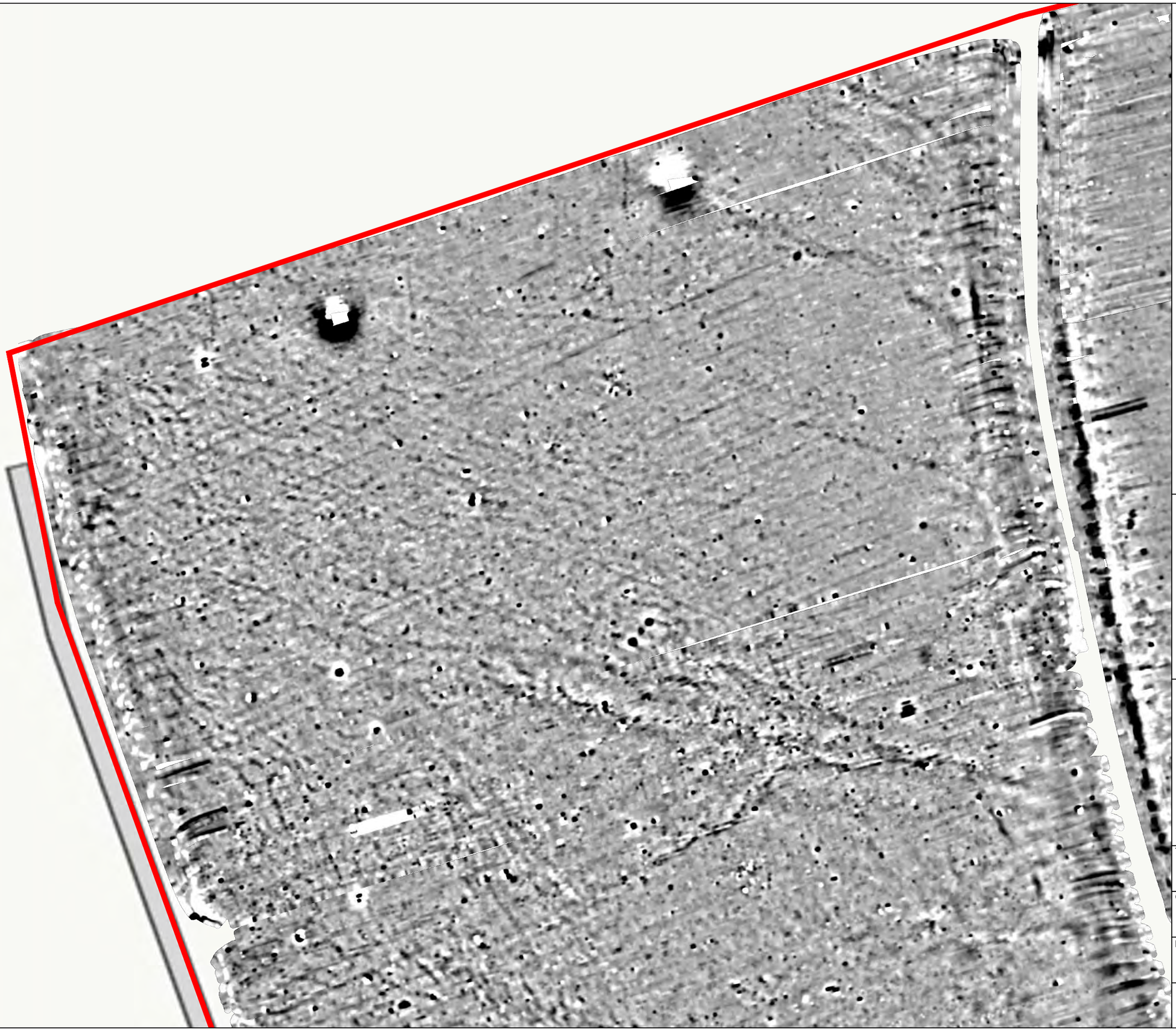

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GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

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Magnetometer Survey - Greyscale Plots

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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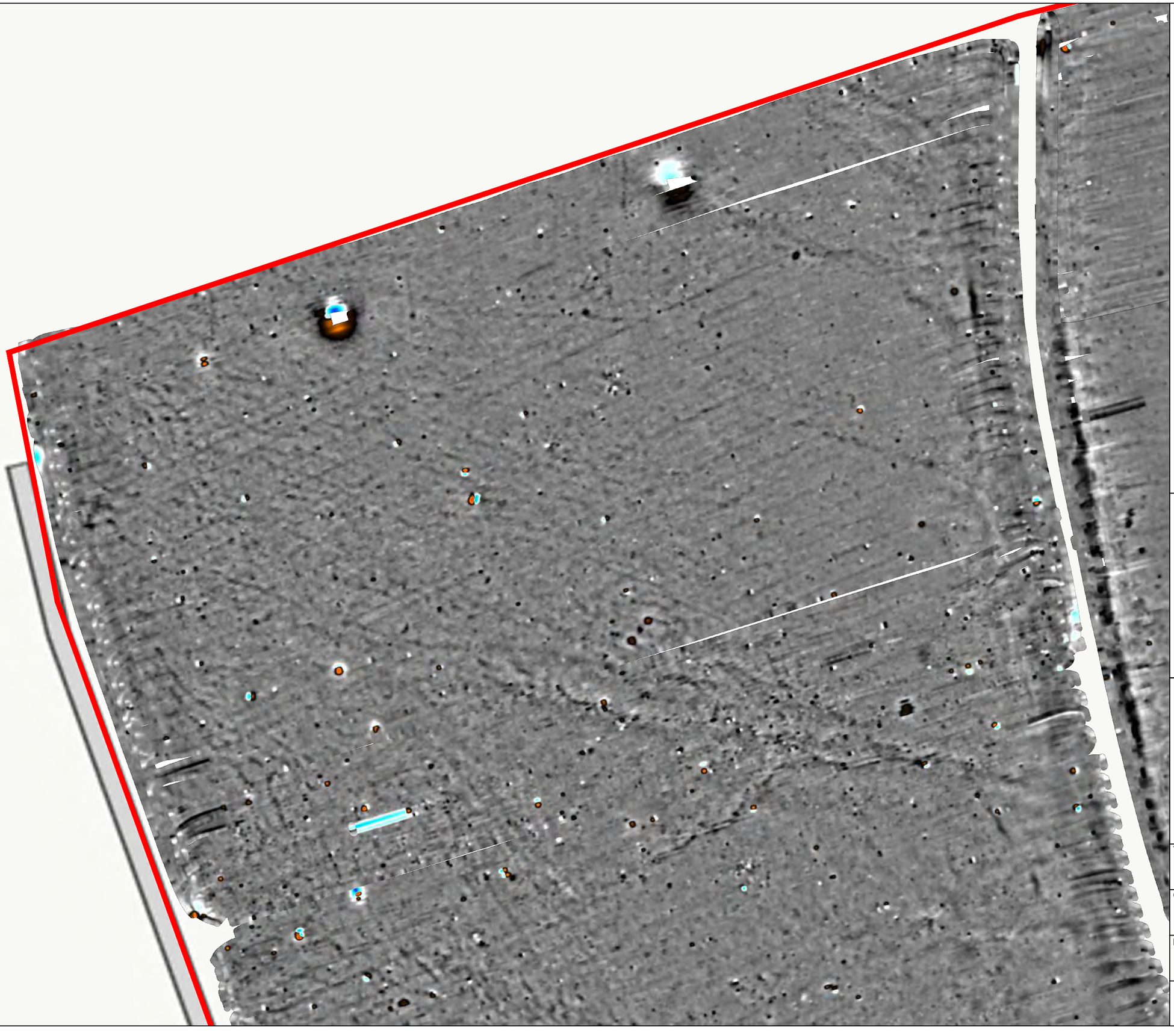

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Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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0 metres 75

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Fig No:

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	Possible archaeology (discrete anomaly / trend)
	Uncertain Origin (trend)
	Agriculture (ridge and furrow)
	Natural (e.g. geological / pedological)
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
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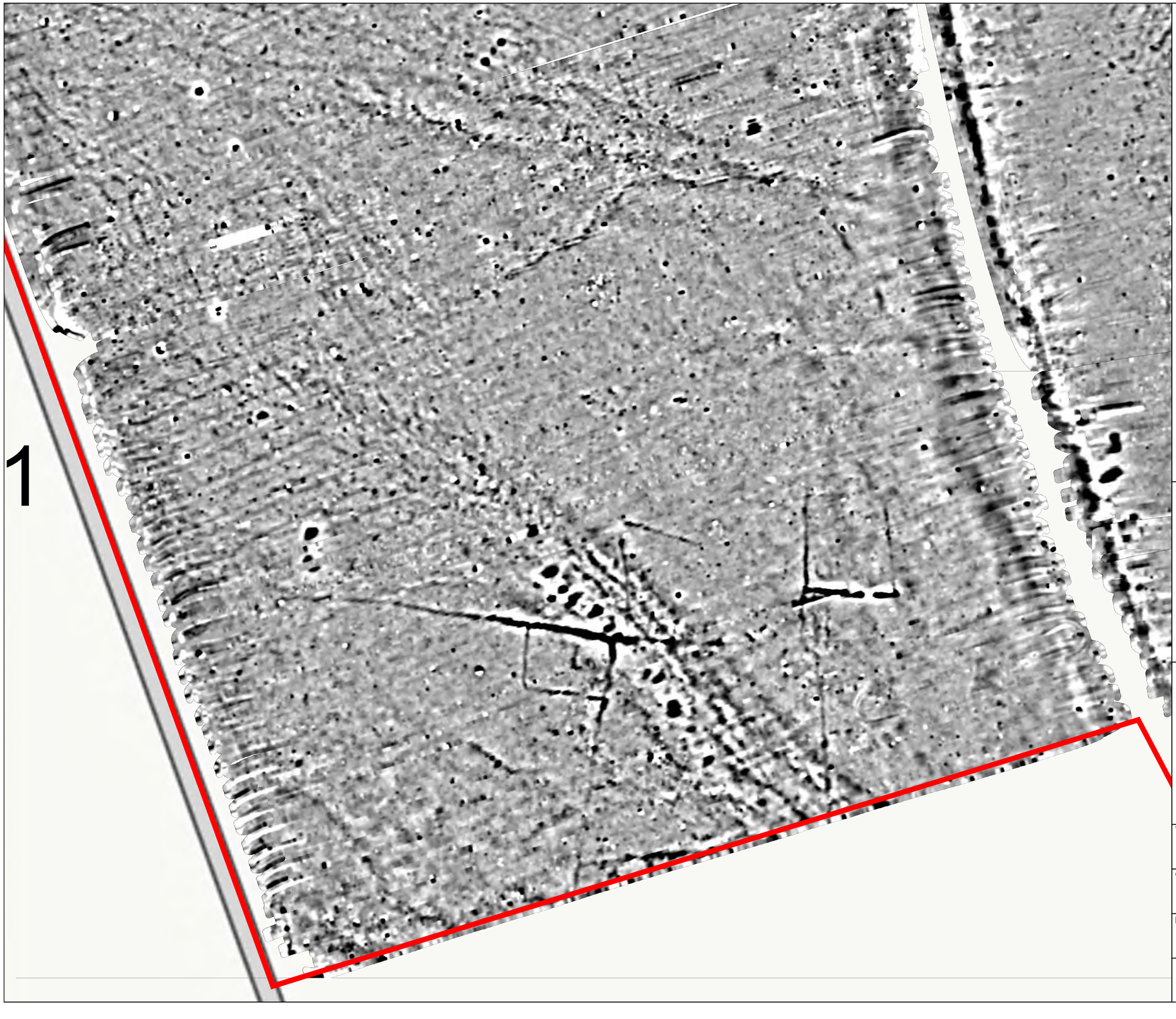

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Orion Heritage Ltd

Project:

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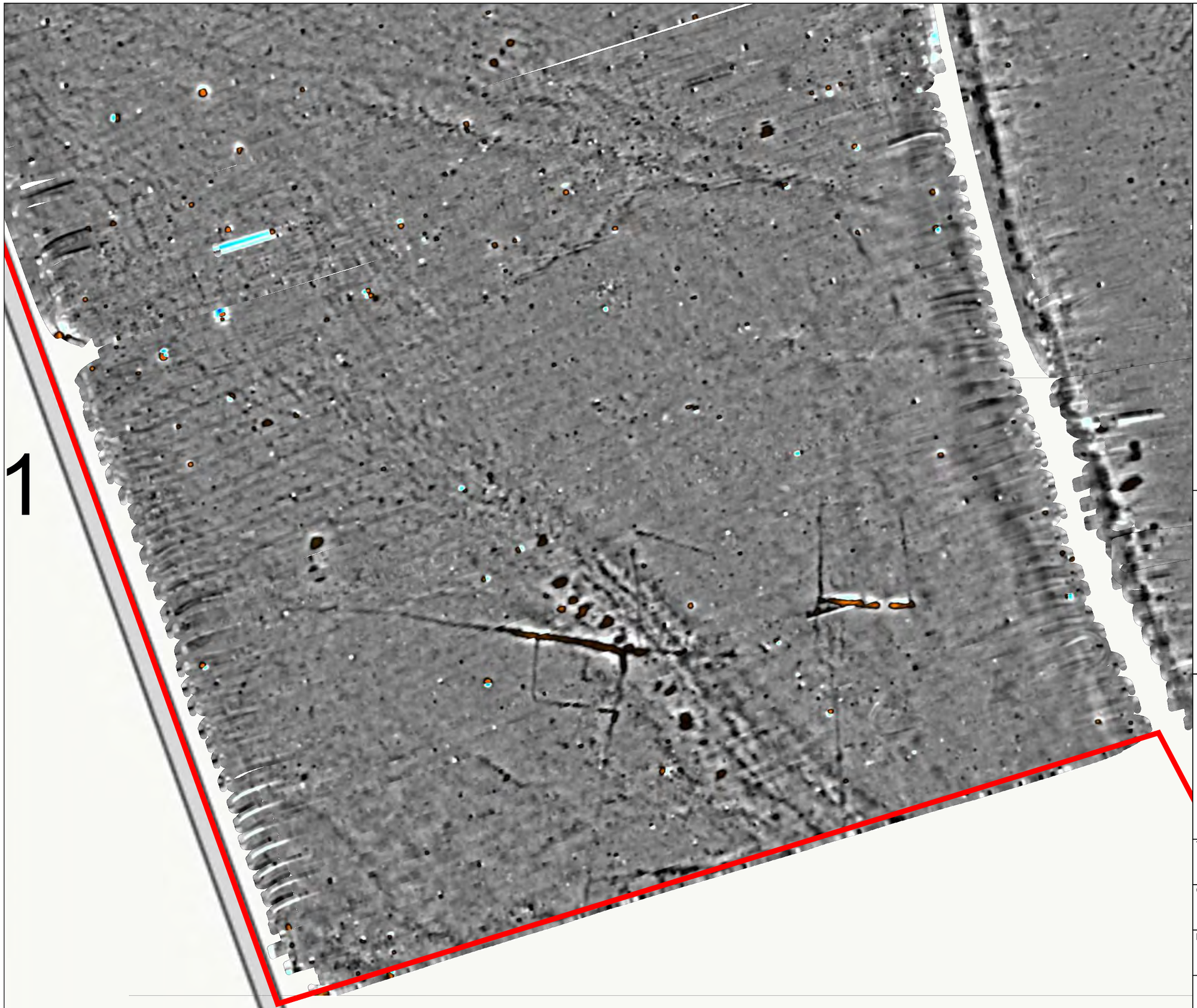

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07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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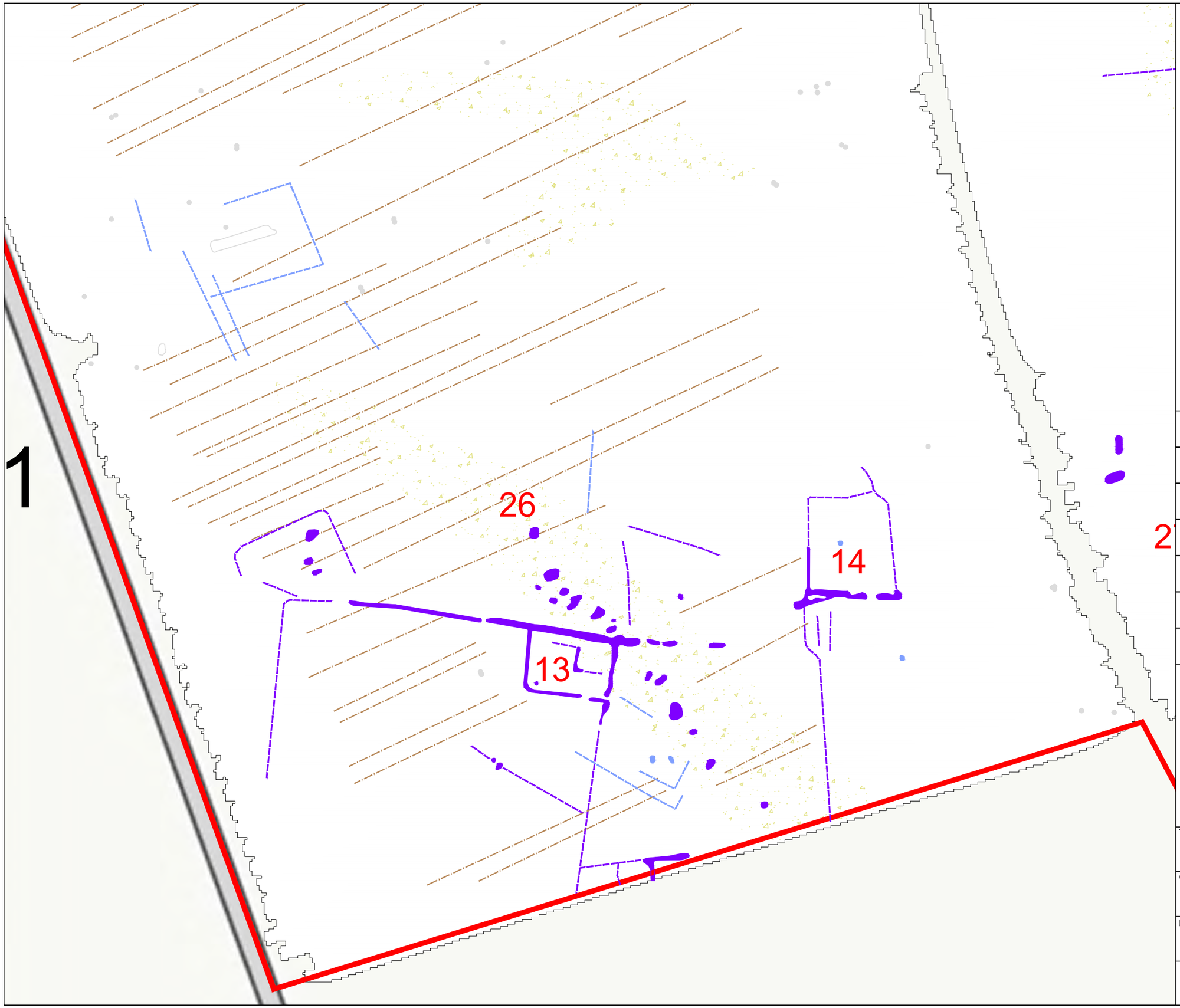

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	Uncertain Origin (trend)
	Agriculture (ridge and furrow)
	Natural (e.g. geological / pedological)
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sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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0 metres 75
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+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

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Magnetometer Survey - Greyscale Plots

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:

0 metres 100

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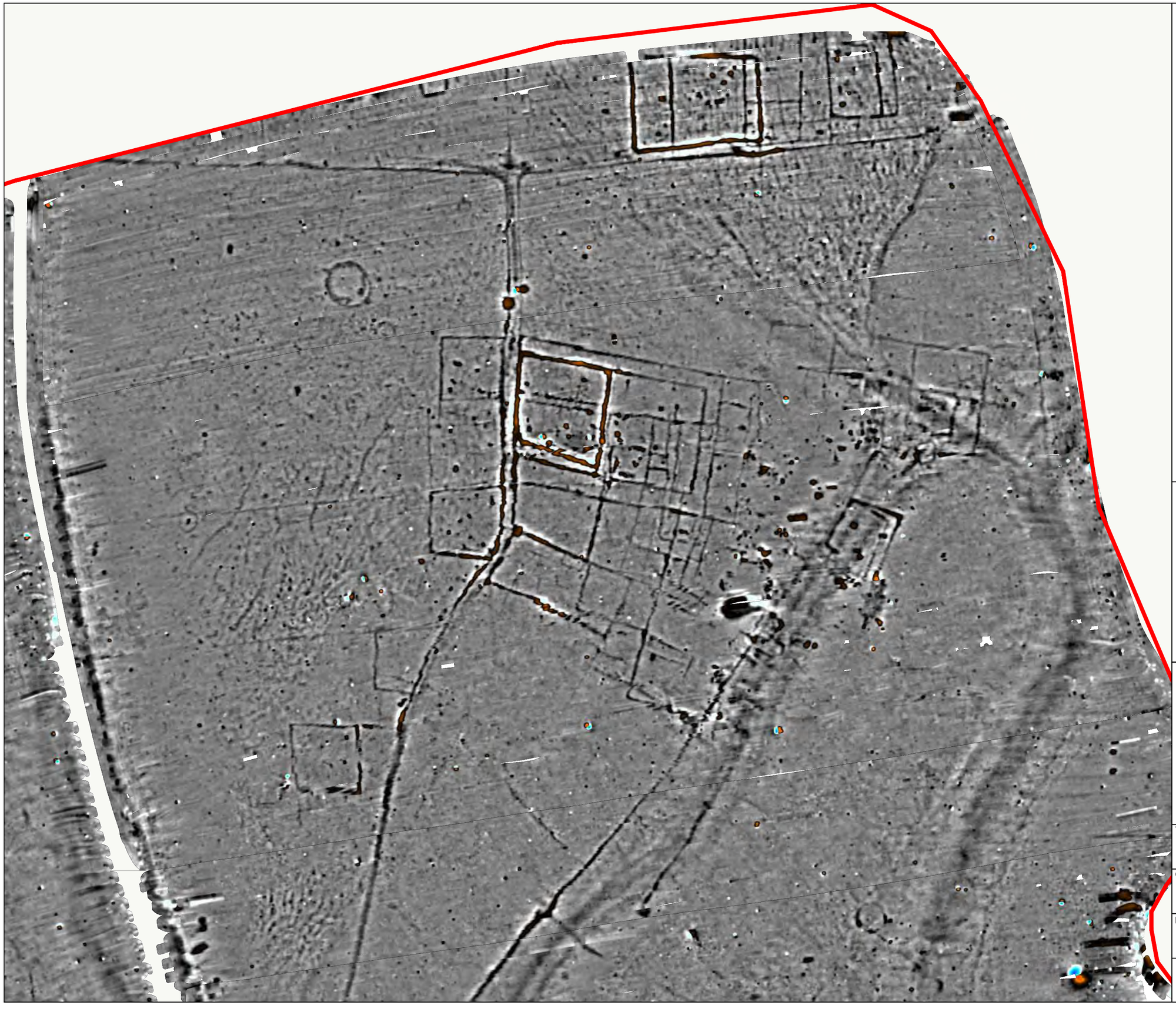

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Magnetometer Survey - Colour Plots

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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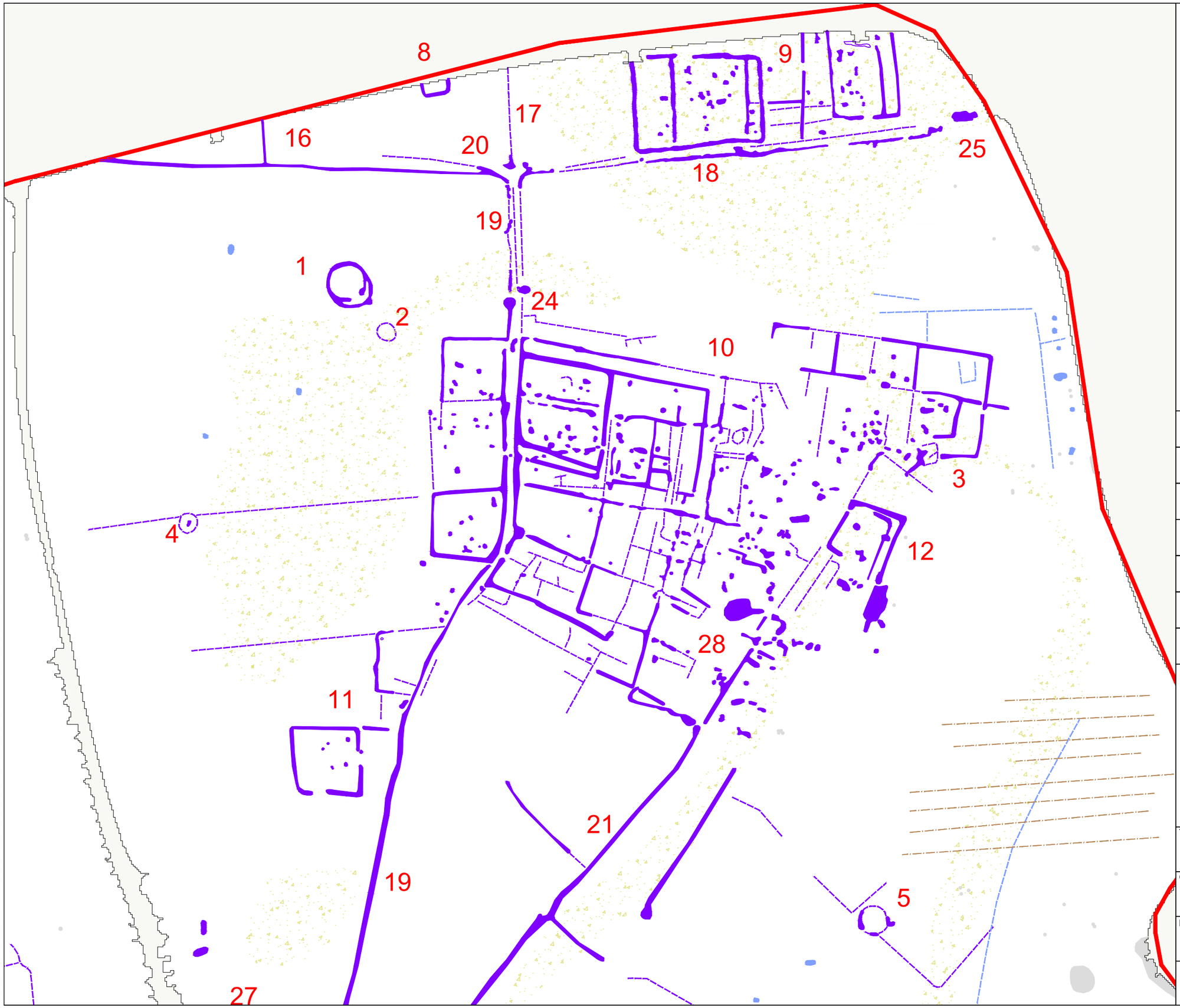

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KEY

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- Possible archaeology (discrete anomaly / trend)
- Uncertain Origin (trend)
- Agriculture (ridge and furrow)
- Natural (e.g. geological / pedological)
- Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
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1:2000 @ A3

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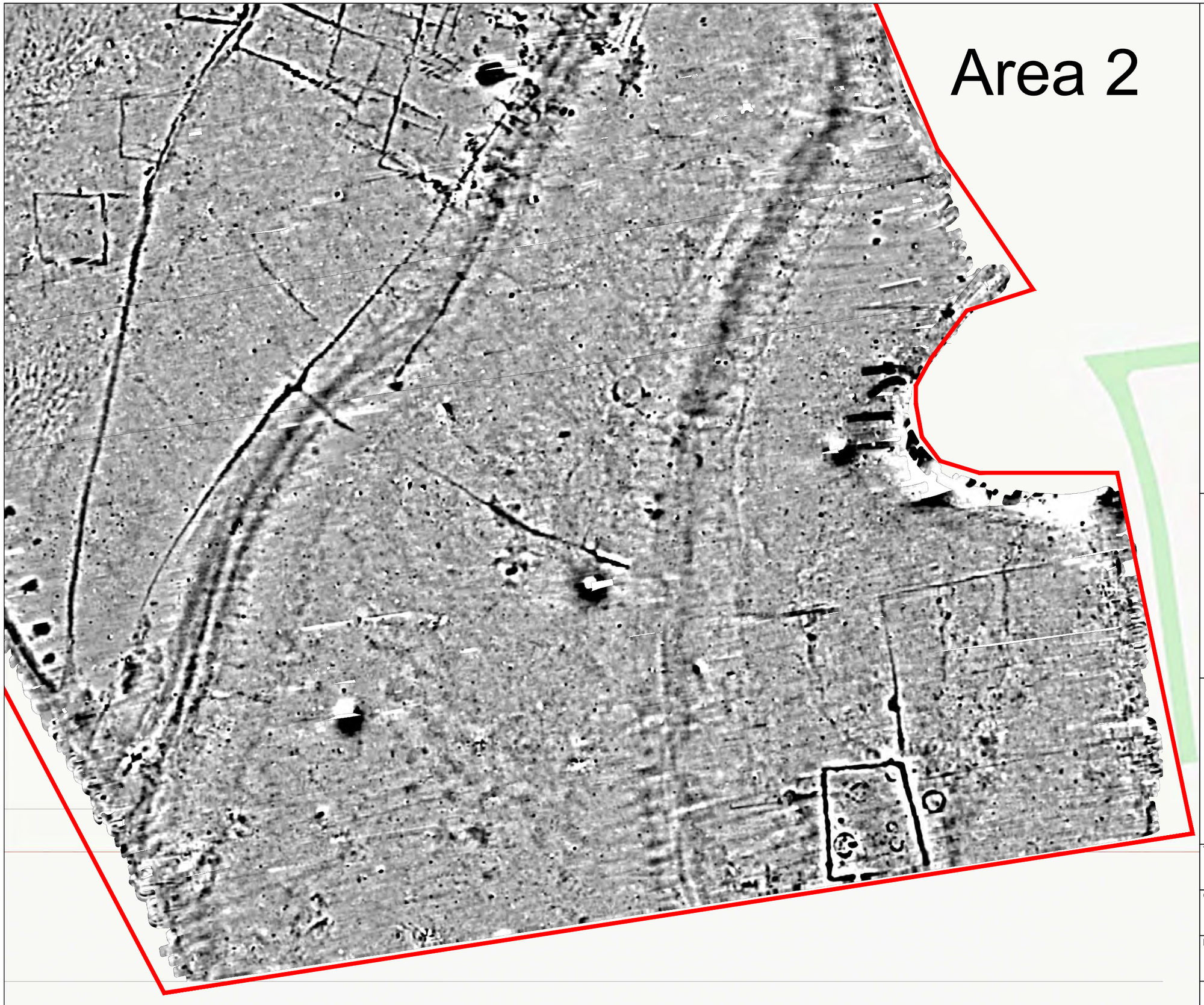

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+2nT

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sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
14

Area 2

N

+100nT

-100nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Colour Plots

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:

0 metres 100

1:2000 @ A3

Fig No:

15

Area 2

12
28
11
21
19
5
22
23
15
6
7

N

KEY

- Probable archaeology (discrete anomaly / trend)
- Possible archaeology (discrete anomaly / trend)
- Uncertain Origin (trend)
- Agriculture (ridge and furrow)
- Natural (e.g. geological / pedological)
- Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

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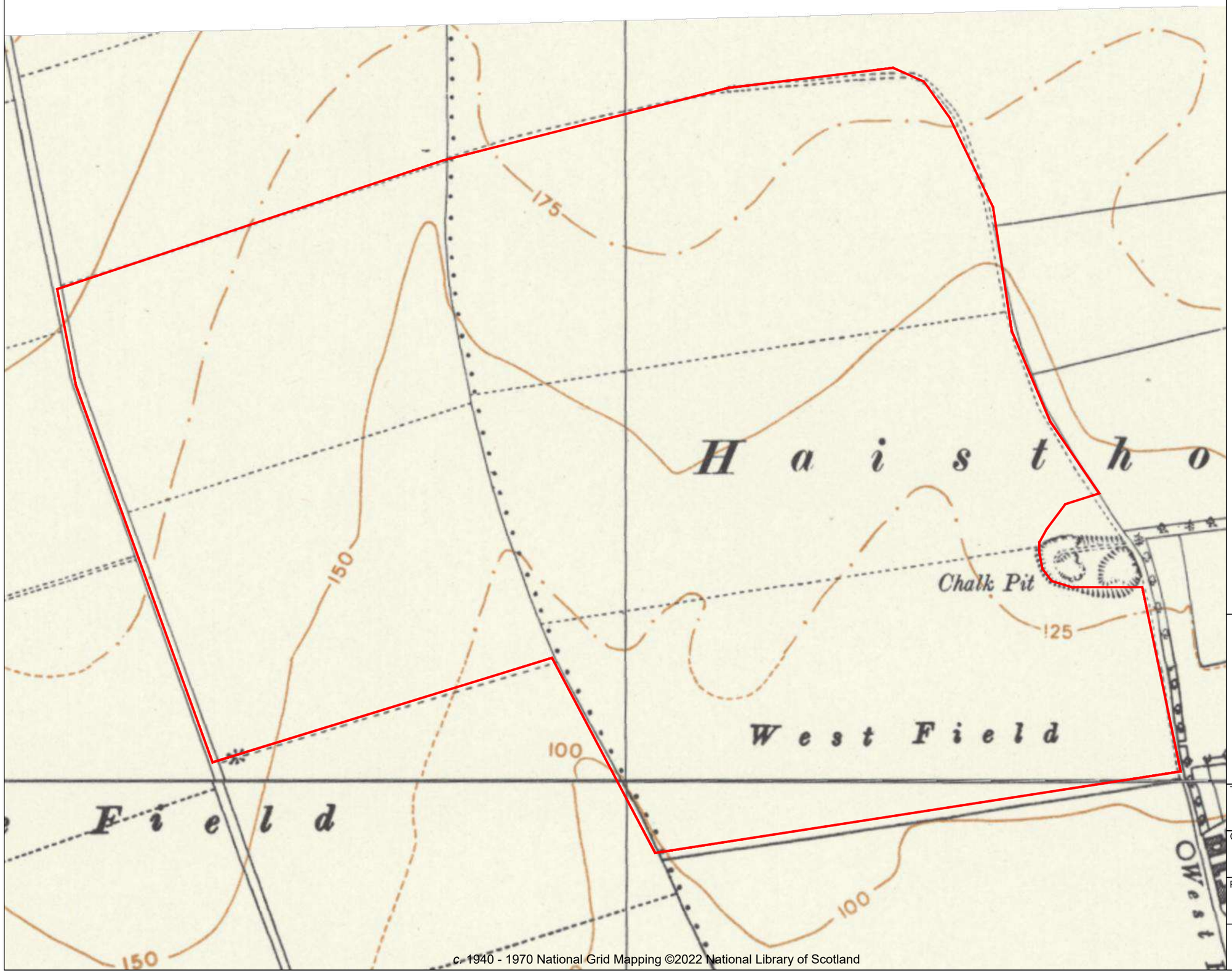

c. 1940 - 1970 National Grid Mapping ©2022 National Library of Scotland

N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
1940-1970 National Grid Mapping

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
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1:4000 @ A3

Fig No:
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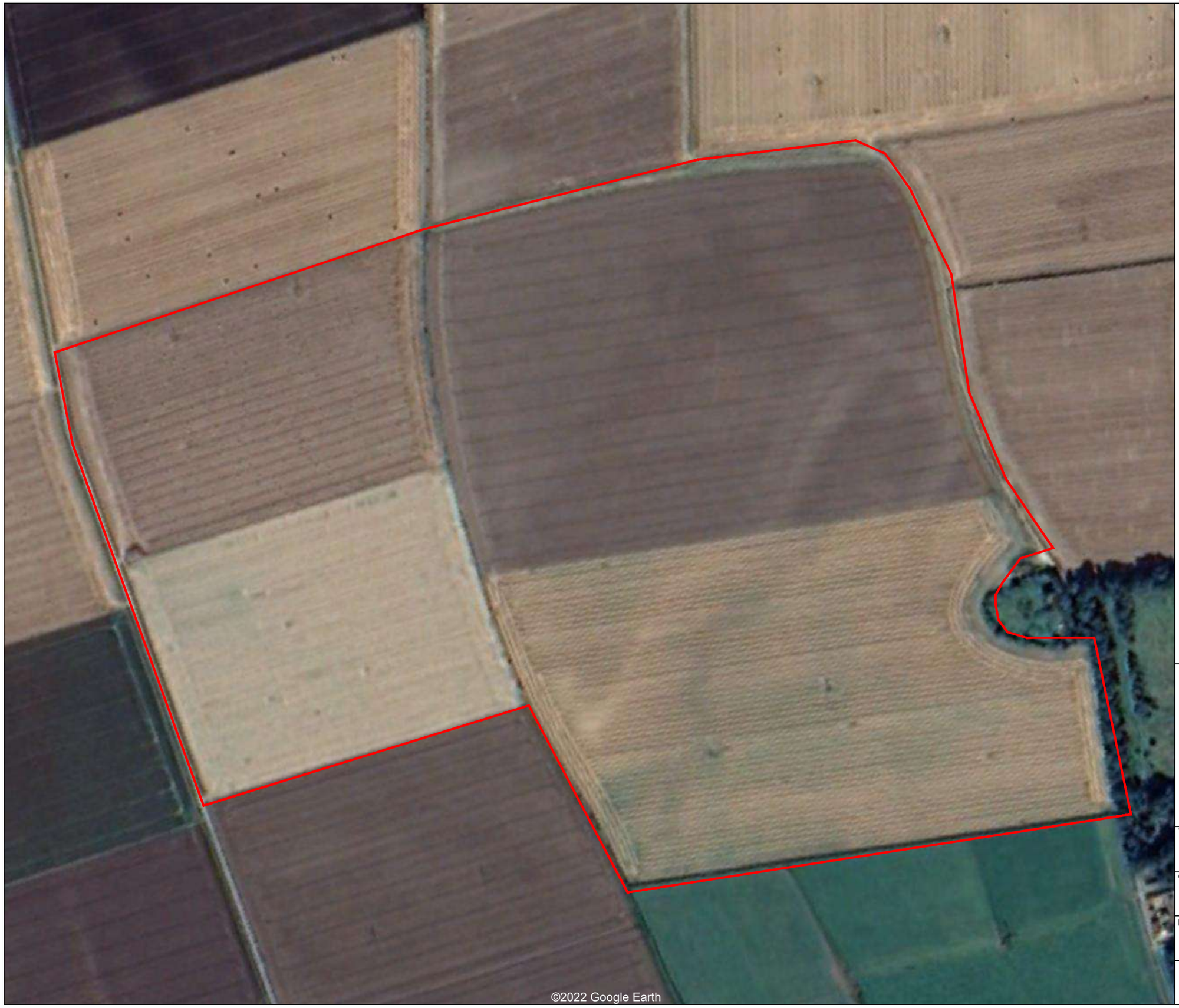

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sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
2019 Aerial Imagery

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 200
1:4000 @ A3

Fig No:
18

N

+10nT

-10nT

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Minimally Processed Data - Greyscale Plots

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 200
1:2000 @ A3

Fig No:
19

N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

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

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

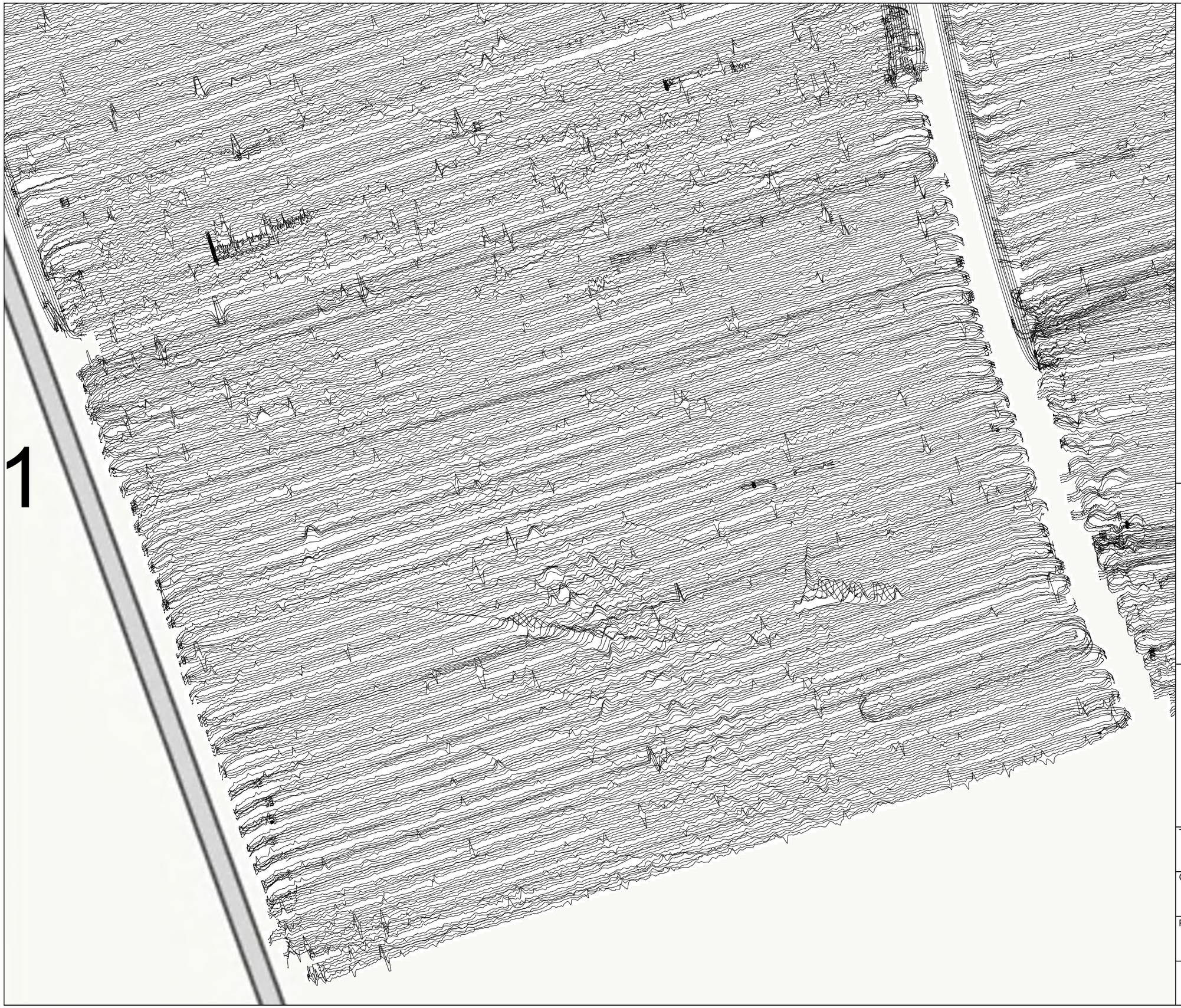
Scale:

0 metres 75

1:1500 @ A3

Fig No:

20



N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

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

Client:

Orion Heritage Ltd

Project:

07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

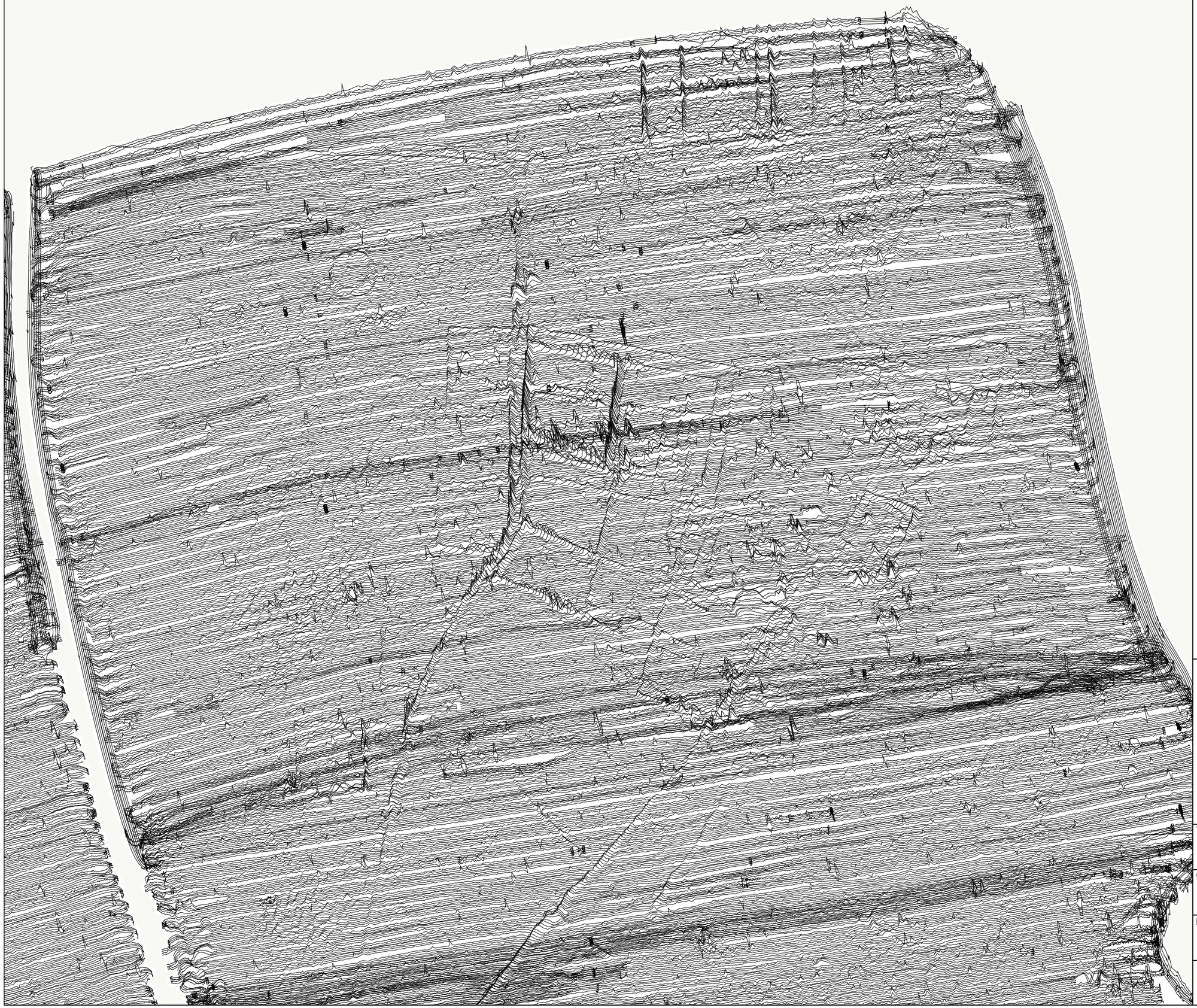
Scale:

0 metres 75

1:1500 @ A3

Fig No:

21



N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

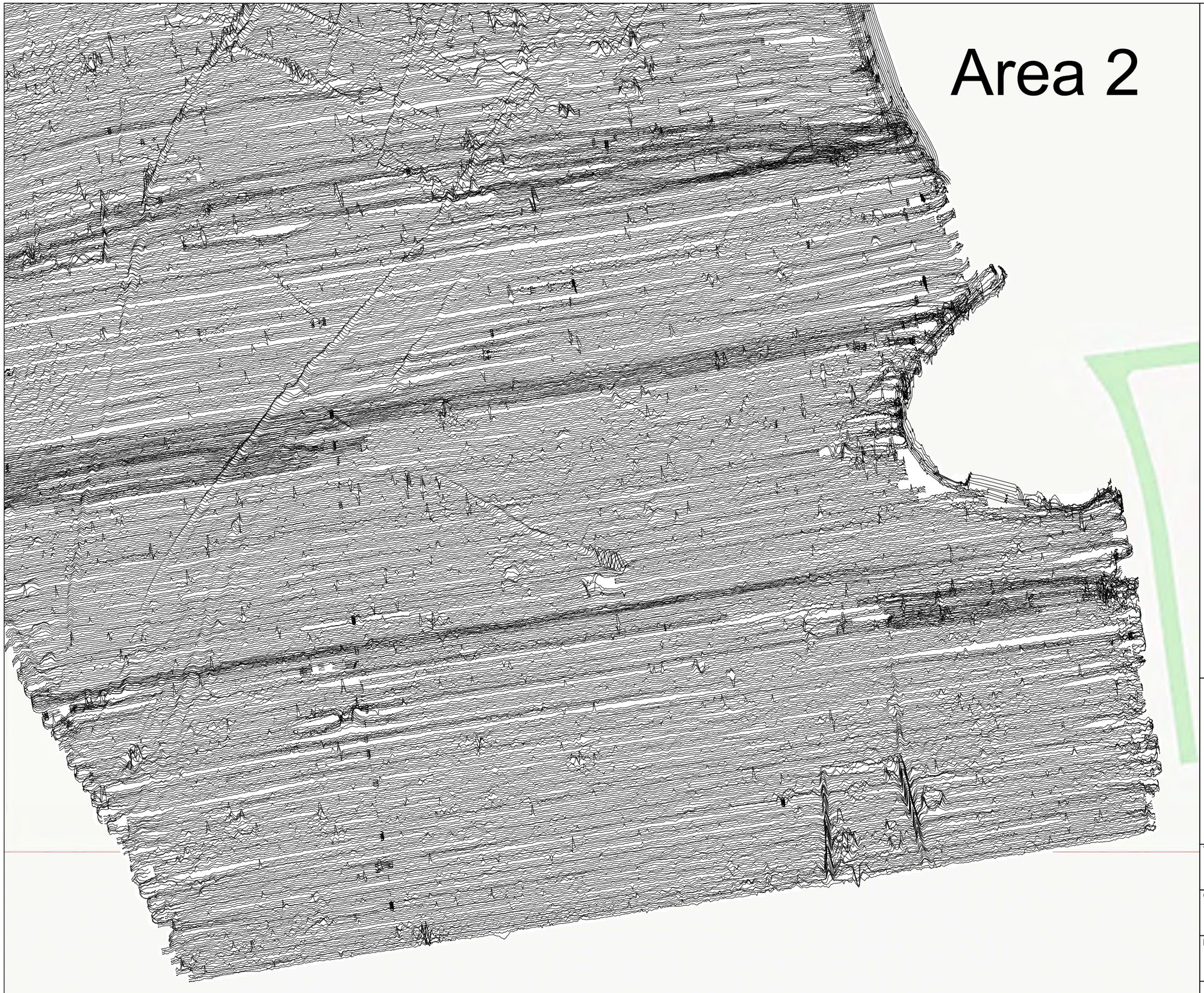
Title:
XY Trace Plots (clipped at +/-15nT)

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
22



N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

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

Client:
Orion Heritage Ltd

Project:
07268 - Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
14

Appendix A - Technical Information: Magnetometer Survey Method, Processing and Presentation

Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (EH 2008) (then English Heritage), the Chartered Institute for Archaeologists (CIfA 2014) and the European Archaeological Council (EAC 2016).

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	1m	0.25m

Instrumentation: Bartington *Grad* 601-2

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, 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. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m. The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each site survey, data is transferred to the office for processing and presentation.

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.

Presentation of results and interpretation

The presentation of the results includes a ‘minimally processed data’ and a ‘processed data’ greyscale plot. Magnetic anomalies are identified, interpreted and plotted onto the ‘Interpretation’ drawings.

When interpreting the results, several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to other existing evidence, the anomalies will be given specific categories, such as: Abbey Wall or Roman Road. Where the interpretation is based largely on the geophysical data, levels of confidence are implied, for example: Probable, or Possible Archaeology. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification Possible.

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.

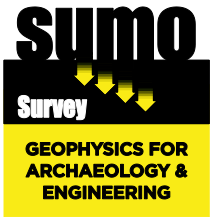
Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same 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 sumogeop1-506589

OASIS ID (UID)	sumogeop1-506589
Project Name	Geophysical Survey at Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire
Sitename	
Activity type	Geophysical Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	07268
Planning Id	
Reason For Investigation	Planning requirement
Organisation Responsible for work	SUMO Geophysics Ltd.
Project Dates	23-Mar-2022 - 07-Apr-2022
Location	Three Oaks Renewable Energy Park, Haisthorpe, East Yorkshire NGR : TA 12020 65315 LL : 54.0715994234411, -0.289596874857533 12 Fig : 512020,465315
Administrative Areas	Country : England County : East Riding of Yorkshire District : East Riding of Yorkshire Parish : Burton Agnes Parish : Carnaby
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	A magnetometer survey of some 64 hectares of land north-west of Haisthorpe, East Yorkshire, has identified a plethora of magnetic responses which are indicative of a range of archaeological sites and features extending across much of the survey area. The results are interpreted as including an extensive multi-period settlement site; several rectilinear enclosures and fields; a number of possible square and round barrows; lines of large pits or burials; and several roads, droveways or boundary ditches. Additionally, palaeo-landscape features have been identified.

Keywords	Ridge And Furrow - MEDIEVAL - FISH Thesaurus of Monument Types Ring Ditch - LATER PREHISTORIC - FISH Thesaurus of Monument Types Square Barrow - IRON AGE - FISH Thesaurus of Monument Types Round Barrow - LATER PREHISTORIC - FISH Thesaurus of Monument Types Rectangular Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types Ditch - UNCERTAIN - FISH Thesaurus of Monument Types Pit - UNCERTAIN - FISH Thesaurus of Monument Types Trackway - UNCERTAIN - FISH Thesaurus of Monument Types Subrectangular Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types
Funder	
HER	Humber HER - unRev - STANDARD
Person Responsible for work	John, Gater
HER Identifiers	
Archives	



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

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