WYAS Archaeological Services

# Belvoir Solar Farm

# Bottesford

# Leicestershire

## Geophysical Survey

Report no. 3476
October 2020

**Client:**

JBM Solar Projects 10 Ltd

# Belvoir Solar Farm, Bottesford, Leicestershire

## Geophysical Survey

*Summary*

*A geophysical (cart-based magnetometer) survey was undertaken on approximately 134 hectares of land located to the south of Bottesford, Leicestershire. Anomalies of a possible archaeological origin have been detected including a ring ditch, sub-rectangular enclosures, linear features and pit-like responses. Medieval ridge and furrow cultivation have also been detected along with former field boundaries and modern ploughing. Geological responses can be seen throughout whilst ferrous responses are associated with modern debris, pylons and overhead power cables. Based on the geophysical survey and interpretation of the results the archaeological potential of the site is medium to high in the northwest and low elsewhere.*

WYAS Archaeological Services

## Report Information

| | |
|---|---|
| Client: | JBM Solar Projects 10 Ltd |
| Address: | 33 Cavendish Square, London, W1G 0PW |
| Report Type: | Geophysical Survey |
| Location: | Bottesford |
| County: | Leicestershire |
| Grid Reference: | SK 8212 3747 (approximate centre) |
| Period(s) of activity: | Modern |
| Report Number: | 3476 |
| Project Number: | X195 |
| Site Code: | BTD20 |
| OASIS ID: | archaeol1-405580 |
| Date of fieldwork: | September 2020 |
| Date of report: | October 2020 |
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| | Alastair Trace BSc MSc |
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| Photography: | Chris Sykes & Alastair Trace |
| Research: | Alastair Trace |
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# 1 Introduction

Archaeological Services ASWYAS has been commissioned by Pegasus Group on behalf of JBM Solar Projects 10 Ltd to undertake a geophysical survey at Belvoir Solar Farm, Bottesford, Leicestershire. This was undertaken in line with current best practice (CIfA 2014; Schmidt *et al.* 2015). A Written Scheme of Investigation was approved by Richard Clark, Principal Archaeologist at Leicestershire County Council, on 25th August 2020. The survey was carried out between 7th and 25th September 2020 to provide additional information on the archaeological resource of the site.

### Site location, topography and land-use

The site is located at SK 8212 3748 (approximate centre), comprising *c*. 134ha situated to the south of Bottesford (see Fig. 1).

The site is almost completely bound by agricultural land with the A52, Bottesford Bypass lying to the north, to the west is Castle View Road. At the time of survey the land consisted of recently harvested crop. The site lies at 45m (above Ordnance Datum) aOD in the north, falling to approximately 39m aOD in the south. In the east the aOD is 49m falling to 40m aOD in the west.

### Soils and geology

The underlying geology of the site is relatively complex, containing a mixture of formations. From north to south; the sedimentary bedrock belongs to the Beckingham Member, followed by the Stubton Limestone Beds, the Foston Member and finally the Littlegate Limestone Beds. All of these bedrocks were formed 191 to 199 million years ago during the Jurassic Period. Superficial deposits of River Terrace deposits – undifferentiated sand and gravels are in the very northwest corner. Elsewhere on site they have not been recorded (BGS 2020). The majority of soil in the survey are described as lime-rich loamy and clayey soils with impeded drainage (SoilScapes 2020).

# 2 Archaeological Background

The archaeological background below has been provided by Pegasus Group and is based on a review of the National Heritage List for England (NHLE), Leicestershire Historic Environment Record (HER) data available online at Heritage Gateway and historic maps available online at The Genealogist and the National Library of Scotland.

Three ‘monuments’ are recorded within the site by the HER. All are located in the north-western corner, between Castle View Road and the A52. They comprise the cropmarks of a possible Bronze Age ring ditch and associated linear ditch (MLE3405), the cropmarks of a

possible Iron Age sub-rectangular enclosure (MLE343404), and the findspot of an Anglo-Saxon brooch (MLE9243).

Further evidence of prehistoric and Saxon activity is recorded immediately to the north-east of the site, on the north side of Easthope Lane. First identified as cropmarks, a targeted excavation carried out in 1988 revealed a sub-rectangular enclosure preserving evidence for ironworking; it seems to have been in use during the Iron Age and infilled gradually during the Roman and Saxon periods (MLE3400).

Also in the vicinity of the site are numerous 'monuments' relating to medieval settlement and activity. Earthworks recorded at 'California', immediately to the west of the site on the opposite side of Castle View Road, may signify the location of Toston deserted village (MLE9845). Earthworks to the east of the site at Muston represent the remains of a moated grange (MLE16636).

The earliest available historic mapping of the site is the 1849 tithe map for the parish of Muston. It shows a slightly greater number of fields than exist today, but no buildings are identified. The land was owned by the Duke of Rutland and was attached to Peacock Farm. No features of note are marked within the site on the first or later editions of the Ordnance Survey.

## 3 Aims, Methodology and Presentation

The aims and objectives of the programme of geophysical survey were to gather sufficient information to establish the presence/absence, character and extent, of any archaeological remains within the specific area and to inform an assessment of the archaeological potential of the site. To achieve this aim, a magnetometer survey covering all amenable parts of the site was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

**Magnetometer survey**

The survey was undertaken using an eight channel SenSYS MX V3 system containing eight FGM650 sensors. Readings are taken every 20MHz (between 0.05 and 0.1m). Data were recorded onto a device, using a Carlson GNSS Smart antenna, for centimetre accuracy. These

readings were stored in the memory of the instrument and downloaded for processing and interpretation. DLMGPS and MAGNETO software, alongside bespoke in-house software was used to process and present the data. Further details are given in Appendix 1.

**Reporting**

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 displays processed magnetometer data at a scale of 1:7500 whilst Figure 3 shows an overview of the interpretation at the same scale. Minimally processed data, together with interpretation of the survey results are presented in Figures 4 to 25 inclusive at a scale of 1:1500.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1. Technical information on locating the survey area is provided in Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the completed OASIS form is included in Appendix 4.

The survey methodology, report and any recommendations comply with guidelines outlined by the European Archaeological Council (Schmidt *et al*. 2015) and by the Chartered Institute for Archaeologists (CIfA 2014). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

***The figures in this report have been produced following analysis of the data in processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.***

## 4 Results and Discussion (see Figures 4 to 25)

**Ferrous anomalies and magnetic disturbance**

Ferrous anomalies, as individual 'spikes', or as large discrete areas are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution in this survey to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Large circular areas of magnetic disturbance within Fields 13 and 15 correspond to the location of large steel pylons. Between these pylons, the overhead power cables and their

electromagnetic effect have caused a 'mottled' affect in the data and has been marked on the interpretation diagrams.

Bisecting the middle of the survey area (through Fields 7, 8, 10, 12 and 11), a linear dipolar trend has been recorded which corresponds to a buried service.

**Geological anomalies**

The survey has detected a number of anomalies that have been interpreted as geological in origin. It is thought that the responses have been detected because of the variation in the composition and depth of the deposits of superficial material in which they derive.

The survey data is very smooth and suggests that the underlying geological deposits are not causing undue interference or masking the magnetic signatures of any archaeological remains.

Where the geological anomalies have been detected they are located close to field margins and this suggests that these areas may have been subjected to slightly deeper ploughing, therefore bringing more of the underlying geology to the surface.

**Agricultural anomalies**

Former field boundaries have been detected throughout the survey area and are recorded on first edition Ordnance Survey mapping dating from 1884 (NLS 2020). These boundaries can be seen in Fields 2, 3, 4, 5, 6, 8, 10, 12, 13 and 15. The historical mapping indicates that there was little change to the layout of the fields from 1884 until the latest available online mapping dated 1990. The current digital mapping seems to show certain field boundaries that no longer exist.

Parallel linear trends can be seen within all areas and are associated with both modern ploughing and medieval ridge and furrow cultivation. The survey area lies between the medieval settlements recorded at California (MLE9845) to the west of site and at Muston (MLE16636) to the east. It is likely that the ridge and furrow detected forms part of the wider medieval agricultural landscape.

**Possible archaeological anomalies**

Anomalies of a possible archaeological origin have been recorded in the northwest of the dataset and sporadically throughout.

Anomalies (**P1, P2** and **P3**) in Field 1 relate to the HER entry named 'Cropmarks north of Easthorpe Cottage' Ref MLE3404/5. The HER refers to a possible ring ditch which could be **P1**, a possible sub-rectangular enclosure **P2** and linear features **P3**. The ring ditch measures approximately 20m in diameter whilst the sub-rectangular enclosure measures approximately 32m in length by 10m in width. The linear feature **P3** has been recorded as a series of pit-like

responses. It is likely that the ploughing within this field has truncated the feature, rather than it being a series of pits, although this cannot be ruled out. A number of other responses within this area have been recorded as possible archaeology and may be contemporary.

Anomalies (**P4** and **P5**) in Field 2 show further possible archaeological areas of interest, both in the forms of sub-rectangular enclosures. Anomaly **P4** measures approximately 60m in length and 8m in width, with internal divisions. **P5** is located along the eastern boundary of the survey area but measures 23m in length and at least 15m in width. Although located adjacent to a field boundary this could be a small enclosure perhaps of prehistoric or later date. A number of other faint linear responses can be seen within this area.

A faint response (**P6**) in Field 16, in the south of the survey area has been recorded. It measures approximately 16m x 12m and may be associated with an enclosure. However, given the isolation of this feature with no other similar responses in this area, the interpretation is tentative.

## 5 Conclusions

The geophysical survey has detected a number of magnetic anomalies with possible archaeological origins in the north-western part of the site. These were formerly identified as cropmarks and appear to represent sub-rectangular enclosures, linear features, a ring ditch and pits.

Medieval ridge and furrow cultivation has been recorded along with former field boundaries and modern ploughing. Geological anomalies have been recorded throughout due to variations within the soils. A service pipe runs through the middle of the survey area on a northwest to southeast alignment. Other modern responses are associated with pylons, overhead power cables and modern debris.

Based on the geophysical survey and interpretation of the results the archaeological potential of the site is medium to high in the northwest and low elsewhere.

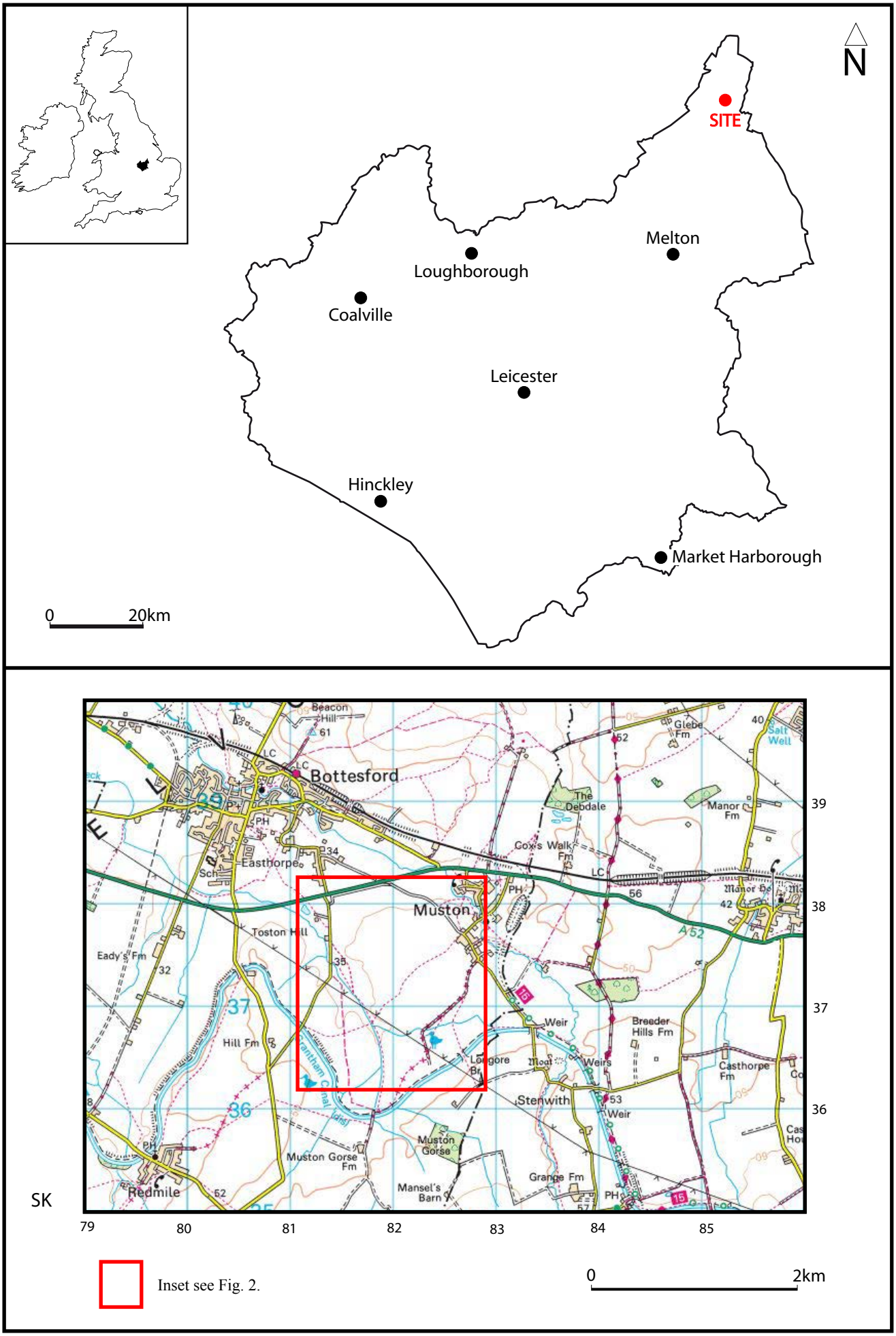


*Fig. 1. Site location*

| PROJECT ID: X195_BTD20 | |
|---|---|
| | SURVEY AREA |
| | SECTOR BOUNDARY |
| 1 | PHOTO LOCATIONS |
| 1 | FIELD NUMBERS |

N

SECTOR 1
SEE FIGS 4-5

SECTOR 2
SEE FIGS 6-7

SECTOR 3
SEE FIGS 8-9

SECTOR 4
SEE FIGS 10-11

SECTOR 5
SEE FIGS 12-13

SECTOR 6
SEE FIGS 14-15

SECTOR 7
SEE FIGS 16-17

SECTOR 8
SEE FIGS 18-19

SECTOR 9
SEE FIGS 20-21

SECTOR 10
SEE FIGS 22-23

SECTOR 11
SEE FIGS 24-25

2.0
-1.0
nT

338000
337000
336000
482000




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0 250m

*Fig. 2. Survey location showing processed greyscale magnetometer data (1:7500 @ A3)*

| PROJECT ID: X195_BTD20 | |
|---|---|
| | SURVEY AREA |
| | SECTOR BOUNDARY |

N

SECTOR 1
SEE FIGS 4-5

SECTOR 2
SEE FIGS 6-7

SECTOR 3
SEE FIGS 8-9

SECTOR 4
SEE FIGS 10-11

SECTOR 5
SEE FIGS 12-13

SECTOR 6
SEE FIGS 14-15

SECTOR 7
SEE FIGS 16-17

SECTOR 8
SEE FIGS 18-19

SECTOR 9
SEE FIGS 20-21

SECTOR 10
SEE FIGS 22-23

SECTOR 11
SEE FIGS 24-25

P1 P2 P3 P4 P5 P6

338000

337000

336000

482000

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| • | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | DIPOLAR LINEAR | SERVICE PIPE |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | OVERHEAD POWERLINES |
| | LINEAR TREND | INTERFERENCE |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |
| | MAGNETIC ENHANCEMENT | ARCHAEOLOGY? |




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0 250m

*Fig. 3. Overall interpretation of magnetometer data (1:7500 @ A3)*

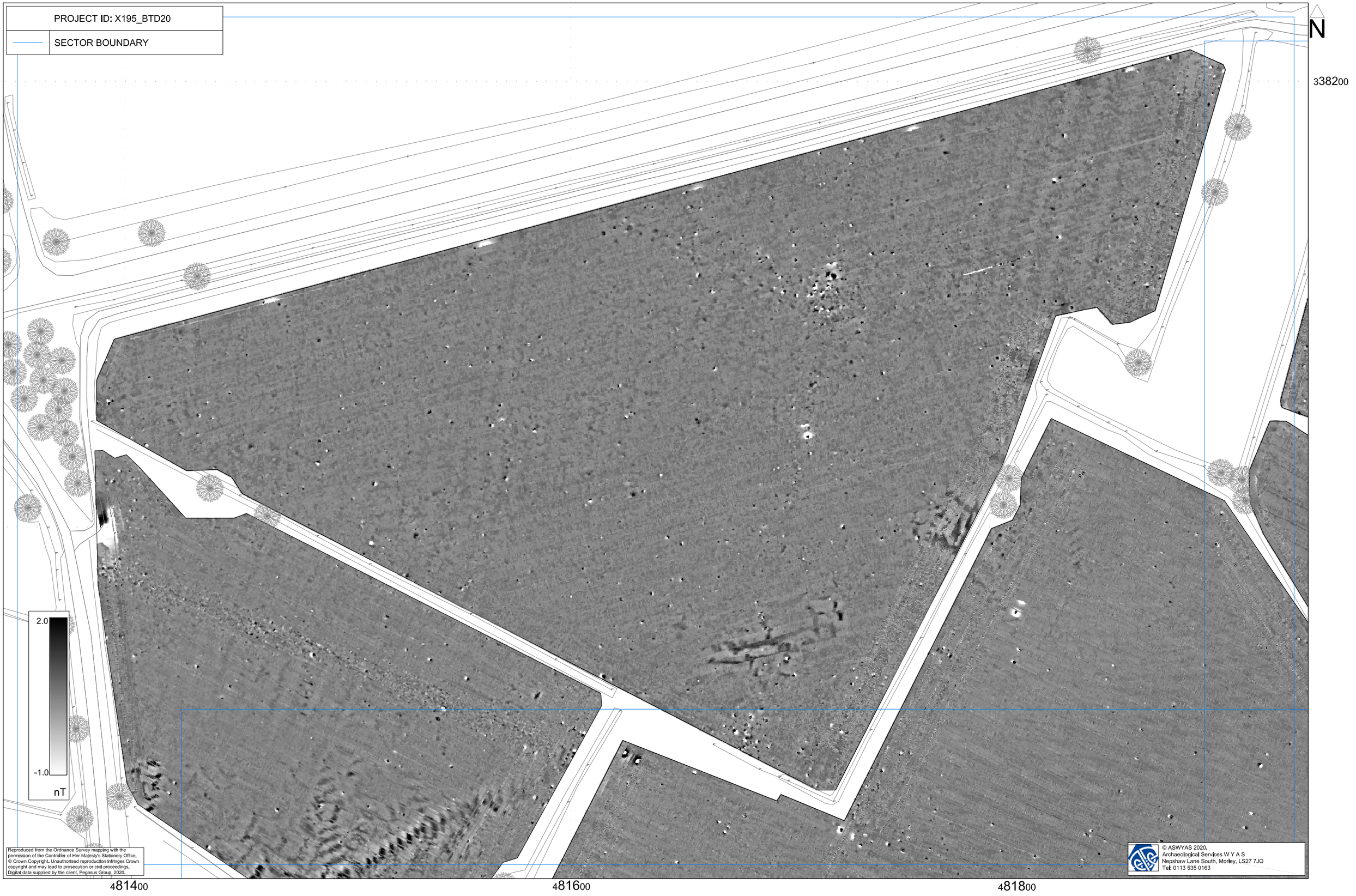


*Fig. 4. Minimally processed greyscale magnetometer data; Sector 1 (1:1500 @ A3)*

| PROJECT ID: X195_BTD20 | |
|---|---|
| | SECTOR BOUNDARY |

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |
| | MAGNETIC ENHANCEMENT | ARCHAEOLOGY? |

N

338200

P1

P2

P3

P4

P5




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481400 481600 481800

0 100m

*Fig. 5. Interpretation of magnetometer data; Sector 1 (1:1500 @ A3)*

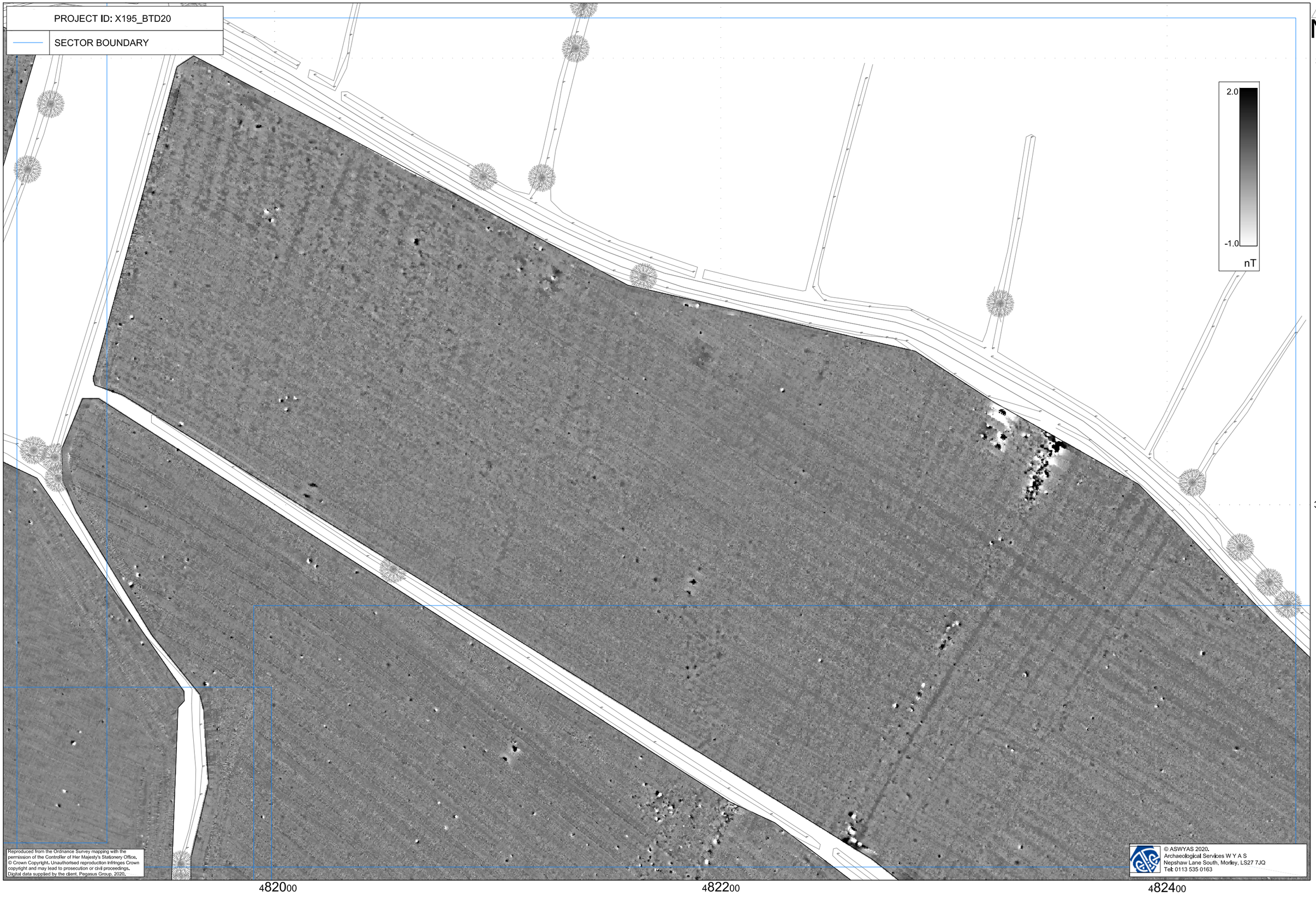


*Fig. 6. Minimally processed greyscale magnetometer data; Sector 2 (1:1500 @ A3)*

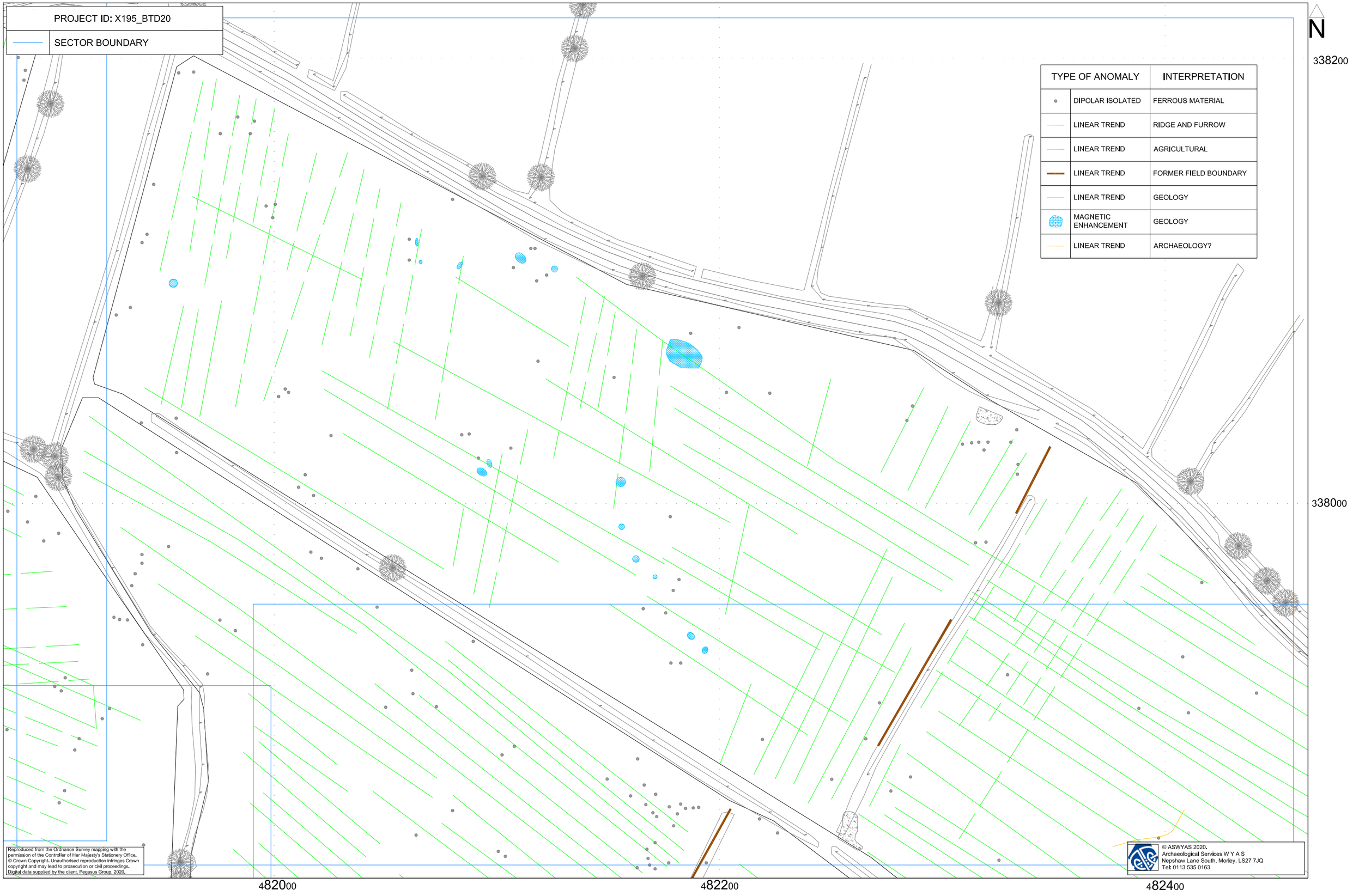


*Fig. 7. Interpretation of magnetometer data; Sector 2 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

N

337800

2.0

-1.0

nT

376600




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481600

481800

0 100m

*Fig. 8. Minimally processed greyscale magnetometer data; Sector 3 (1:1500 @ A3)*

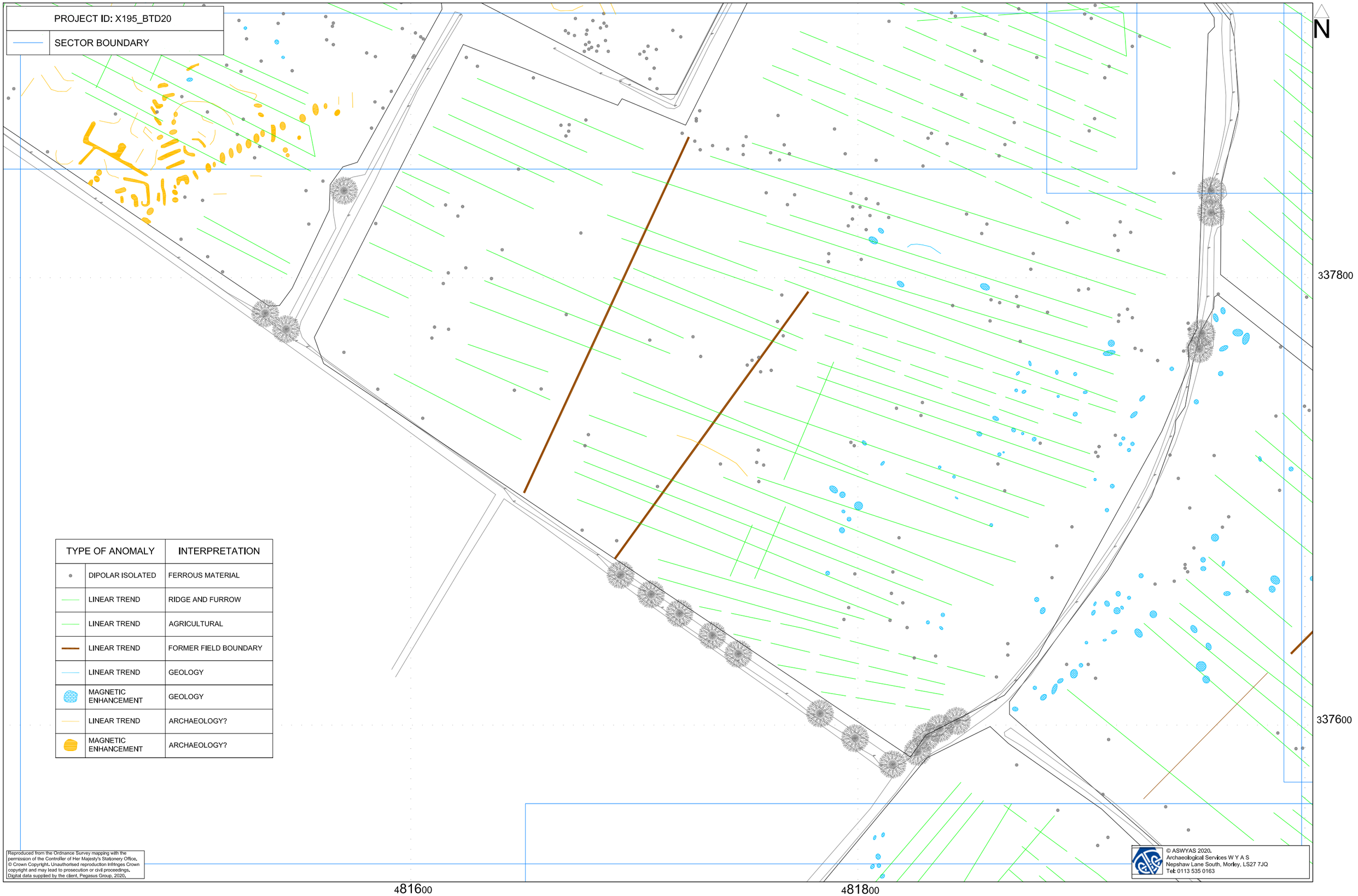


*Fig. 9. Interpretation of magnetometer data; Sector 3 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

337800

2.0

-1.0

nT

337600



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482200

482400

0

100m

*Fig. 10. Minimally processed greyscale magnetometer data; Sector 4 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

N

337800

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |

337600




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482200

482400

0 100m

*Fig. 11. Interpretation of magnetometer data; Sector 4 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

2.0

-1.0

nT

337400

337200

482000

0 100m



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*Fig. 12. Minimally processed greyscale magnetometer data; Sector 5 (1:1500 @ A3)*

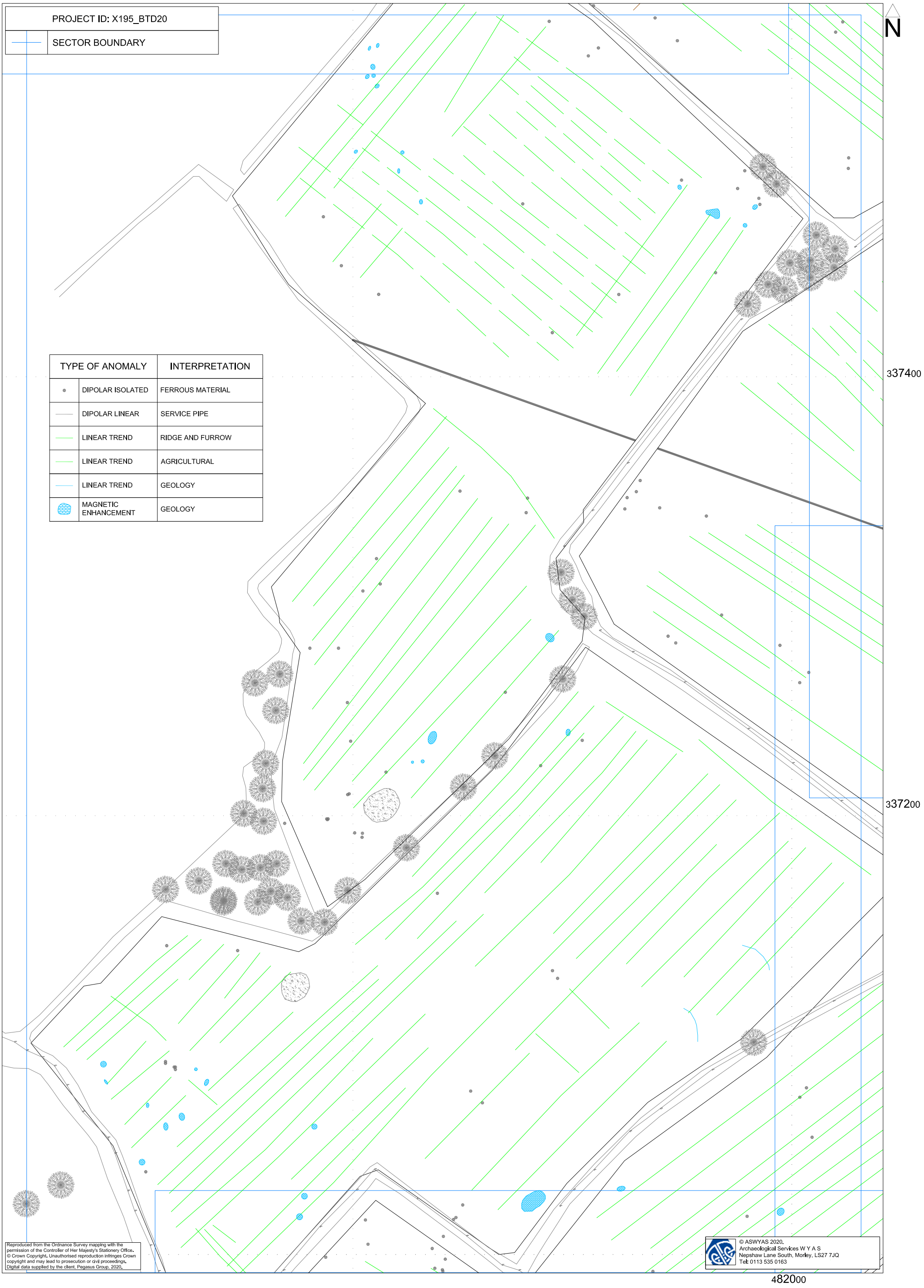


*Fig. 13. Interpretation of magnetometer data; Sector 5 (1:1500 @ A3)*

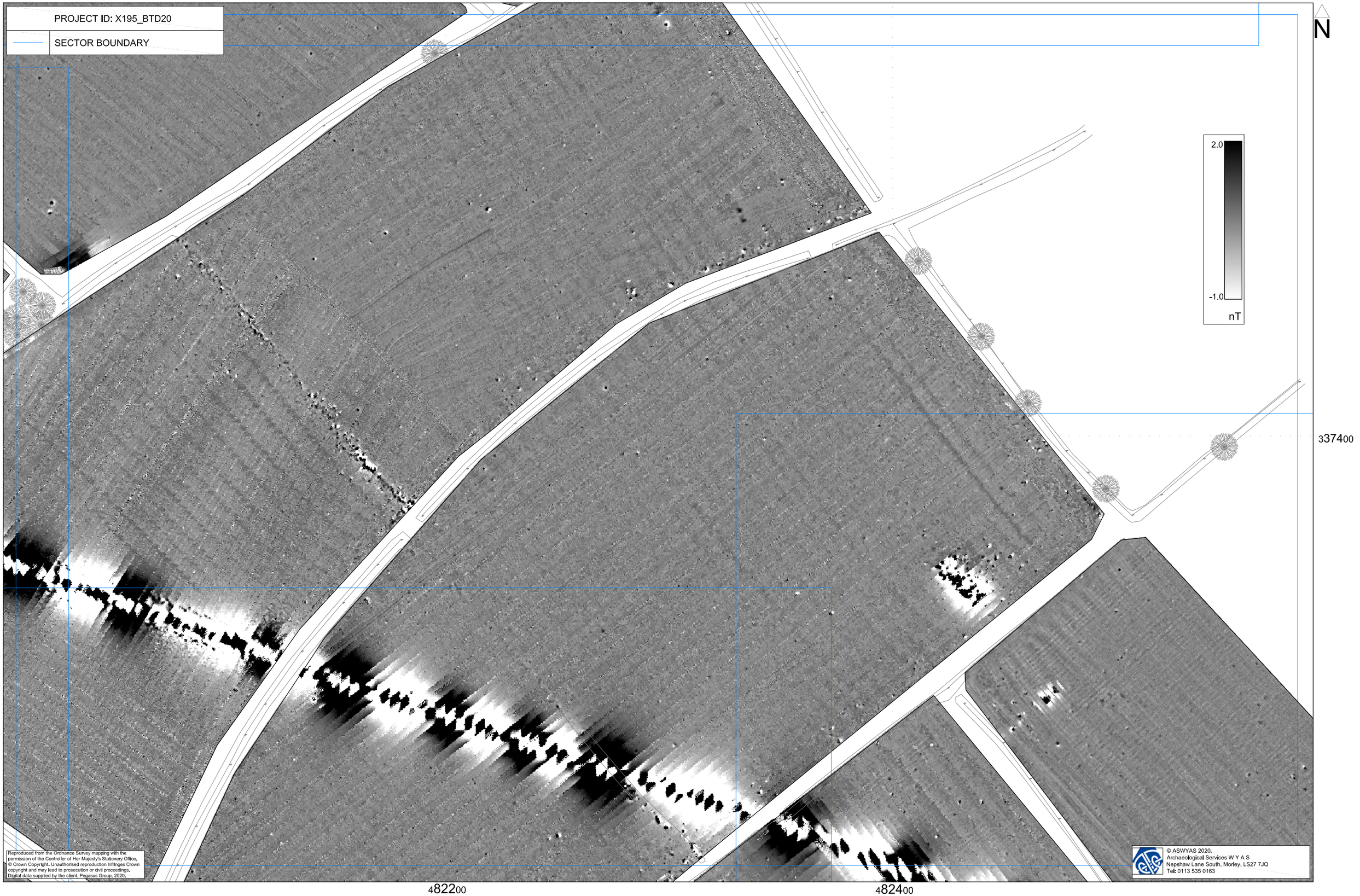


*Fig. 14. Minimally processed greyscale magnetometer data; Sector 6 (1:1500 @ A3)*

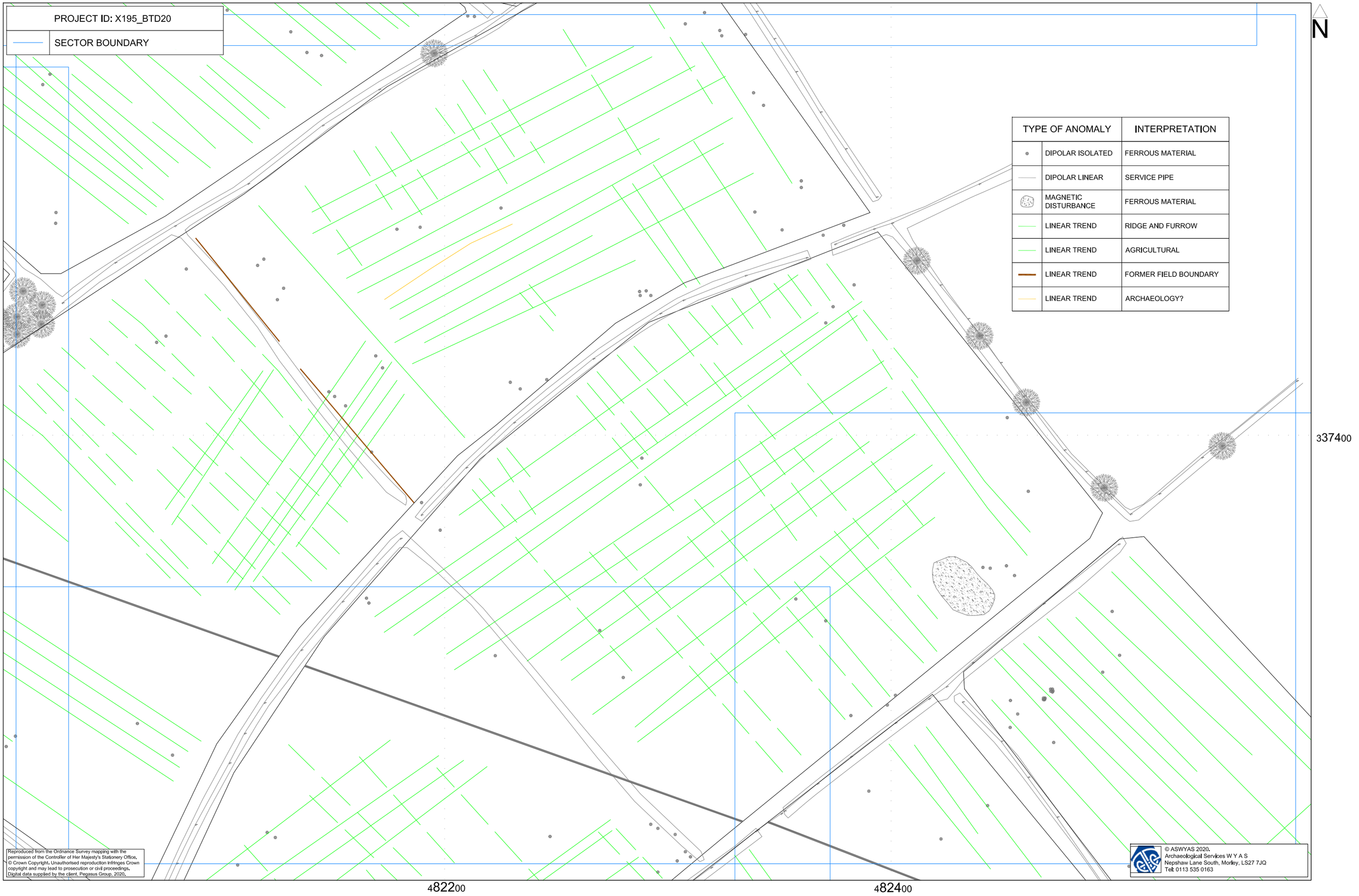


*Fig. 15. Interpretation of magnetometer data; Sector 6 (1:1500 @ A3)*


*Fig. 16. Minimally processed greyscale magnetometer data; Sector 7 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | DIPOLAR LINEAR | SERVICE PIPE |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | OVERHEAD POWERLINES |
| | LINEAR TREND | INTERFERENCE |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |

N

337200

337000

336800

482000

482200




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0 100m

*Fig. 17. Interpretation of magnetometer data; Sector 7 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

337200

337000

482400

482600

2.0

-1.0

nT

0

100m




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*Fig. 18. Minimally processed greyscale magnetometer data; Sector 8 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | DIPOLAR LINEAR | SERVICE PIPE |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |

337200

337000

482400

482600

0

100m




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*Fig. 19. Interpretation of magnetometer data; Sector 8 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

337000

336800

336600

2.0

-1.0

nT





482400

482600

0

100m

*Fig. 20. Minimally processed greyscale magnetometer data; Sector 9 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

N

337000

336800

336600

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| • | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | DIPOLAR LINEAR | SERVICE PIPE |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | OVERHEAD POWERLINES |
| | LINEAR TREND | INTERFERENCE |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |




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482400

482600

0

100m

*Fig. 21. Interpretation of magnetometer data; Sector 9 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

N

336800

336600

336400

482200

2.0

-1.0

nT

0

100m



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*Fig. 22. Minimally processed greyscale magnetometer data; Sector 10 (1:1500 @ A3)*

PROJECT ID: X195_BTD20

SECTOR BOUNDARY

N

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | OVERHEAD POWERLINES |
| | LINEAR TREND | INTERFERENCE |
| | LINEAR TREND | RIDGE AND FURROW |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |

336800

336600

336400

482200




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0 100m

*Fig. 23. Interpretation of magnetometer data; Sector 10 (1:1500 @ A3)*

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SECTOR BOUNDARY

N

336400

336200

336000

482000

2.0

-1.0

nT




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0 100m

*Fig. 24. Minimally processed greyscale magnetometer data; Sector 11 (1:1500 @ A3)*

SECTOR BOUNDARY

N

P6

| TYPE OF ANOMALY | | INTERPRETATION |
|---|---|---|
| ● | DIPOLAR ISOLATED | FERROUS MATERIAL |
| | MAGNETIC DISTURBANCE | FERROUS MATERIAL |
| | LINEAR TREND | INTERFERENCE |
| | LINEAR TREND | AGRICULTURAL |
| | LINEAR TREND | FORMER FIELD BOUNDARY |
| | LINEAR TREND | GEOLOGY |
| | MAGNETIC ENHANCEMENT | GEOLOGY |
| | LINEAR TREND | ARCHAEOLOGY? |
| | MAGNETIC ENHANCEMENT | ARCHAEOLOGY? |




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3364**00**

3362**00**

3360**00**

4820**00**

0 100m

*Fig. 25. Interpretation of magnetometer data; Sector 11 (1:1500 @ A3)*

*Plate 1. General view of Field 1, looking east*

*Plate 2. General view of Field 2, looking south*

*Plate 3. General view of Field 4, looking southeast*

*Plate 4. General view of Field 5, looking east*

*Plate 5. General view of Field 6, looking east*

*Plate 6. General view of Field 7, looking south*

*Plate 7. General view of Field 8, looking north*

*Plate 8. General view of Field 9, looking north*

*Plate 9. General view of Field 11, looking northwest*

*Plate 10. General view of Field 12, looking north*

*Plate 11. General view of Field 13, looking northwest*

*Plate 12. General view of Field 14, looking northwest*

*Plate 13. General view of Field 15, looking south*

*Plate 14. General view of Field 16, looking north*

# Appendix 1: Magnetic survey - technical information

### Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of 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. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough.

### Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

*Isolated dipolar anomalies (iron spikes)*

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

*Areas of magnetic disturbance*

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

*Linear trend*

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

*Areas of magnetic enhancement/positive isolated anomalies*

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

*Linear and curvilinear anomalies*

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

## Methodology: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points,

typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

During this survey an eight channel Sensys MX V3 system containing eight FGM650 sensors was used which was towed across the area using an ATV. Readings were taken every 20MHz (between 0.05 and 0.1m). Data was be recorded onto a device, using a Carlson GNSS Smart antenna, for centimetre accuracy. These readings were stored in the memory of the instrument and downloaded for processing and interpretation

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

## Appendix 2: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 model). The accuracy of this equipment is better than 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

***Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.***

## Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Leicestershire Historic Environment Record).

# Appendix 4: Oasis form

# OASIS DATA COLLECTION FORM: England



## OASIS ID: archaeol11-405580

### Project details

| | |
|---|---|
| Project name | Belvoir Solar Farm, Bottesford |
| Short description of the project | A geophysical (cart-based magnetometer) survey was undertaken on approximately 134 hectares of land located to the south of Bottesford, Leicestershire. Anomalies of a possible archaeological origin have been detected including a ring ditch, sub-rectangular enclosures, linear features and pit-like responses. Medieval ridge and furrow cultivation have also been detected along with former field boundaries and modern ploughing. Geological responses can be seen throughout whilst ferrous responses are associated with modern debris, pylons and overhead power cables. Based on the geophysical survey and interpretation of the results the archaeological potential of the site is medium to high in the northwest and low elsewhere. |
| Project dates | Start: 07-09-2020 End: 25-09-2020 |
| Previous/future work | No / Not known |
| Any associated project reference codes | BTD20 - Sitecode |
| Any associated project reference codes | MLE3405 - SM No. |
| Any associated project reference codes | MLE3404 - SM No. |
| Type of project | Field evaluation |
| Monument type | RING DITCH Bronze Age |
| Monument type | ENCLOSURE Iron Age |
| Significant Finds | RING DITCH Bronze Age |
| Significant Finds | ENCLOSURE Uncertain |
| Methods & techniques | "Geophysical Survey" |
| Development type | Solar |
| Prompt | National Planning Policy Framework - NPPF |
| Position in the planning process | Not known / Not recorded |

| | |
|---|---|
| Solid geology | MAGNESIAN LIMESTONE |
| Drift geology | GLACIAL SAND AND GRAVEL |
| Techniques | Magnetometry |

## Project location

| | |
|---|---|
| Country | England |
| Site location | LEICESTERSHIRE MELTON BOTTESFORD Belvoir Solar Farm, Bottesford |
| Study area | 134 Hectares |
| Site coordinates | SK 8212 3748 52.928120250839 -0.778228936658 52 55 41 N 000 46 41 W Point |
| Height OD / Depth | Min: 39m Max: 49m |

## Project creators

| | |
|---|---|
| Name of Organisation | Archaeological Services WYAS |
| Project brief originator | Pegasus Group |
| Project design originator | Pegasus Group |
| Project director/manager | E Brunning |
| Project supervisor | C. Sykes |

## Project archives

| | |
|---|---|
| Physical Archive Exists? | No |
| Digital Archive recipient | Pegasus Group |
| Digital Contents | "Survey" |
| Digital Media available | "Geophysics","Images raster / digital photography","Survey","Text" |
| Paper Archive Exists? | No |

## Project bibliography 1

| | |
|---|---|
| Publication type | Grey literature (unpublished document/manuscript) |
| Title | Belvoir Solar Farm, Bottesford |
| Author(s)/Editor(s) | Brunning, E |
| Date | 2020 |
| Issuer or publisher | ASWYAS |
| Place of issue or publication | Leeds |
| Description | A4 report with A3 figures |

| | |
|---|---|
| Entered by | Emma Brunning (emma.brunning@aswyas.com) |

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