A47 Blofield to North Burlingham Dualling

Scheme Number: TR010040

Volume 6
6.2 Environmental Statement Appendices
Appendix 6.3 – Geophysical Survey

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

December 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A47 Blofield to North Burlingham Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 6.3 Geophysical Survey

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010040
Application Document Reference	6.2
BIM Document Reference	PCF Stage 3
Author:	A47 Blofield to North Burlingham Dualling Project Team, Highways England

Version	Date	Status of Version
Rev 0	December / 2020	Application Issue

WYAS Archaeological Services

Blofield to North Burlingham

A47

Norfolk

ENF143427

Geophysical Survey

Report no. 3145
June 2018

Client: Mott MacDonald Sweco Joint Venture

Blofield to North Burlingham
A47
Norfolk
ENF143427

Geophysical Survey

Summary

A hand-held and cart-based geophysical (magnetometer) survey, covering approximately 46 hectares was undertaken on land to the south of the A47 between Blofield and North Burlingham. Anomalies of a possible archaeological origin have been recorded in the western and eastern portions of the corridor. A former field boundary has also been detected in the eastern part of the site which corresponds well with recorded boundaries on Ordnance Survey mapping. Ferrous and magnetic disturbance anomalies, along with evidence of a service pipe along the northern edge of the survey corridor, have been detected. Responses associated with a former sand pit are present. The archaeological potential of the site would be characterised as medium to low.

WYAS
Archaeological
Services

Report Information

Client:	Mott MacDonald Sweco Joint Venture
Address:	22 Station Road, Cambridge, CB1 2JD
Report Type:	Geophysical Survey
Location:	A47
County:	Norfolk
Grid Reference:	TG 343 098/ TG 376 098
Period(s) of activity:	?Prehistoric / modern
Report Number:	3145
Project Number:	8234
Site Code:	AIP18
Event Number:	ENF143427
OASIS ID:	archaeol11-321596
Date of fieldwork:	March 2018
Date of report:	August 2018
Project Management:	Emma Brunning BSc MCIfA
Fieldwork:	Chris Sykes BSc MSc MCIfA
	Jake Freeman BA
	Alastair Trace BSc MSc
	Jamie Ranaldi BSc MSc
	Clare Asplin BA
Report:	Emma Brunning and Chris Sykes
Illustrations:	Chris Sykes

Authorisation for distribution: ----------

Nepshaw Lane South, Morley, Leeds LS27 7JQ
Telephone: 0113 535 0163.
Email: admin@aswyas.com

Contents

List of Figures

List of Plates

1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Mott MacDonald Sweco Joint Venture (the client), to undertake a geophysical (magnetometer) survey on land predominantly to the south of the A47, between the eastern extent of Blofield, through to South Walsham Road. This is in advance of junction improvements as part of the A47 improvement programme. The survey was undertaken in line with current best practice (CIfA 2014; David *et al*. 2008) and also to the archaeological specification for geophysical survey prepared by the client on behalf of Highways England (Highways England 2018). The survey was carried out between the 9th April until 3rd May 2018 and the 8th – 10th August 2018.

Site location, topography and land-use

The survey area is located between Blofield and South Walsham Road, on the south-eastern outskirts of Norwich (see Fig. 1). This section of the scheme comprises multiple small sites within the vicinity, bounded by Yarmouth Road (A47) to the north and arable fields to the south. The extent of the survey to the west is bounded by allotments and to the east by the B1140. At the eastern terminus of the scheme, a parcel of land to the immediate north of the A47 and the immediate west of South Walsham road was also surveyed. The survey area encompasses eleven fields of varying ground conditions of arable and pastoral land. The areas total approximately 46 ha. The survey area is centred between TG 343 098 and TG 376 098. The height above Ordnance Datum (aOD) lies between 15m to 26m.

Soils and geology

The bedrock geology of the survey area predominantly belongs to the Crag Group sand and gravel, a sedimentary bedrock formed approximately 0 to 5 million years ago in the Quaternary and Neogene Periods with overlying superficial deposits of the Lowestoft formation formed up to 2 million years ago in the Quaternary Period (BGS 2018). The soils in the area are classified in the Wick 2 association, characterised as deep well drained coarse loamy soils, often stoneless (SSEW 1983).

2 Archaeological Background

Norfolk Historic Environment Record (NHER) data were provided by the client and have been marked on Figure 3. The following illustrates the wealth of archaeological monuments present both within and surrounding the proposed survey area.

A Bronze Age round barrow (NHER 12783) is visible on aerial photographs and lies approximately 500m to the south of BLO1. The barrow forms part of a small cemetery (NHER 49688) along with other barrows located to the west.

To the immediate southwest of NHER 12783 lie cropmarks of a cluster of sub-rectangular pits (NHER 49575), possibly indicating Saxon grubenhauser or later extraction pits. The site consists of a series of oblong and sub-rectangular pit-like features, ranging in length from 4.5-7m and 2.5-6m across. Some of the pits are obviously cut into one another, indicating more than one phase of excavation or extraction. It is possible that the pits could have been created through episodic gravel extraction, although it would be unusual for such neat and rectangular cuts to have been dug. Metal detecting (NHER 25248) recovered a Late Saxon brooch and a fragment of a Late Saxon box mount located to the west of BLO3.

NHER number 49569 lies approximately 650m to the south of BLO1 and consists of a group of undated ditches and field boundaries that are visible on aerial photographs.

To the immediate north of BLO2 cropmarks of a medieval to early post-medieval road (NHER 45143) are visible on aerial photographs as a negative cropmark indicating a compacted or metalled surface. The road is also marked on Faden's 1797 map of Norfolk.

Cropmarks of a rectilinear enclosure of a probable Iron Age to early Roman date are visible on aerial photographs (NHER 18130). The enclosure has an asymmetrical sub-rectangular plan with rounded corners and an entrance is present in the southwest side with a second possible blocked entrance on the northeast side. It is likely that this enclosure is related to a smaller possible enclosure to its north (NHER 45149) and a field system to the northwest (NHER 45150).

To the north of BLO3 and BLO4 cropmarks of a large and dispersed group of enclosures and former field boundaries have been recorded (NHER 49445) of a possible late prehistoric to Roman date. Other cropmarks of multi-period field boundaries and trackways have been recorded (NHER 49614) to the south of BLO3 and BLO4.

To the immediate west of BLO5 cropmarks of possible ditched boundaries are visible on aerial photographs (NHER 49655). Further boundaries have been recorded to the north of BLO6 (NHER 49456).

Earthworks and soilmarks of trackways and boundaries of medieval to post-medieval date are visible on aerial photographs (NHER 49455) to the north of BLO8. It is possible that they relate to an earlier layout of Burlington Hall's park landscape. To the immediate southeast of this record lies NHER 49457 which consists of a possible circular enclosure of unknown date within the grounds of Burlington Hall.

To the northwest of BLO11 soilmarks of a post-medieval tree ring or enclosed copse (NHER 35519) are visible within the grounds of Burlington Hall. This feature is marked on historic maps, including the 1838 Burlington Tithe map. Also to the northwest of BLO11 cropmarks of field boundaries of a possible Iron Age to Roman date (NHER 49463) are visible on aerial photographs.

To the south of BLO8 cropmarks of fragmentary enclosures and field boundaries of unknown date are visible on aerial photographs (NHER 49613).

Possible World War II defences (NHER 49464), potentially spigot mortar emplacements, are visible on aerial photographs and lie within the survey area of BLO11.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim, a magnetometer survey covering all amenable parts of the PDA was undertaken (see Fig. 2).

The general objectives of the geophysical survey were to:

- Locate and identify the nature and extent of previously unknown archaeological features along the proposed route option;
- Establish whether any features associated with known archaeological remains can be traced within the current survey areas;
- Establish whether any remains identified during previous geophysical surveys can be traced continuing into the current survey areas;
- Establish the condition of any archaeological deposits, particularly their level of preservation; and,
- Identify any areas of modern disturbance.

Magnetometer survey

The survey was undertaken using both a Bartington Grad 601-2 magnetometer and a Sensys Magneto®MXPDA cart-based magnetometer system.

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble R6 model). Survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

The cart-based system has five FGM650 fluxgate gradiometers mounted at 0.5m intervals with readings of between ±0.1nT and ±10,000nT recorded at 20Hz. The gradiometers are

linked to a Trimble R6 Real Time Kinetic (RTK) differential Global Positioning System (dGPS) allowing for the geo-referencing of all measurement points within ±1cm accuracy. The data is recorded by Sensys Magneto®MXPDA software on a Personal Data Assistant (PeDA) device and stored on a Secure Digital (SD) memory card within the PeDA. Terrasurveyor (DW Consulting) 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 an overview of the processed magnetometer data at a scale of 1: 10000, with the overall interpretation, at the same scale in Figure 3. The minimally processed data, together with an interpretation of the survey results are presented in Figures 4 to 19 inclusive at a scale of 1:1250.

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. Repeat traverses of the data are included in Appendix 5.

The survey methodology, report and any recommendations comply with guidelines outlined by Historic England (David *et al.* 2008) 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 19)

Modern anomalies

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.

A large isolated area of magnetic disturbance has been detected in the western half of BLO3 (Figs 8-9), which is thought to be infilled material relating to a sand pit chronicled on Ordnance Survey mapping from 1882 until 1972.

A modern service pipe has been recorded along the northern edge of the survey corridor, which cuts through the northern field of BLO8 and along the southern limits of BLO9 and BLO10.

Geological anomalies

The survey has detected a number of low magnitude anomalies in BLO3 and BLO4 (Figs 8-11). There are also some geological responses in BLO10 and BLO11 (Figs 16-19). Given their isolation and magnetic characteristics 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, as well as topographical variations.

Agricultural anomalies

A significant number of modern plough lines have been detected throughout the survey along with a former field boundary in BLO8 (Figs 14-15). This former field boundary is recorded on 1882 mapping and has been removed by 1972 mapping (OM 2018).

Possible archaeological anomalies

A weak magnetic response (**P1**) has been identified in BLO2 (Figs 4-5) as having a possible archaeological response. It has regular characteristic traits associated with a possible enclosure, but given the strength of the anomaly this interpretation is tentative, although given the wealth of archaeological activity in the vicinity it may have an anthropogenic origin. Within the same area, to the east of **P1** a handful of weak linear trends are visible. It is likely that these represent further former field systems which are prevalent in the area.

Further magnetically weak trends are visible in BLO6 and BLO8 which may be a continuation of the recorded field boundaries NHER 49613 and NHER 49456. Curvilinear trends in BLO5 and BLO10 are tentative but may represent ring ditches.

5 Conclusions

The magnetic survey has detected a handful of anomalies of a possible archaeological origin. Whilst they do not correspond with any identified cropmarks in the area, the wealth of archaeological activity in the vicinity adds weight to an archaeological interpretation.

A former field boundary has been identified which corresponds to historical mapping of the area. Areas of disturbance and geological anomalies have also been detected.

The survey has worked reasonably well on this geology and land-use and has detected weak anomalies of a possible archaeological origin. It is possible that the archaeological features have been in-filled with non-magnetic materials or that the amount of topsoil vary across the scheme. However responses of a ferrous nature, along with a service pipe have been detected. Based upon the results of the survey, the archaeological potential of the site is considered to be medium to low.

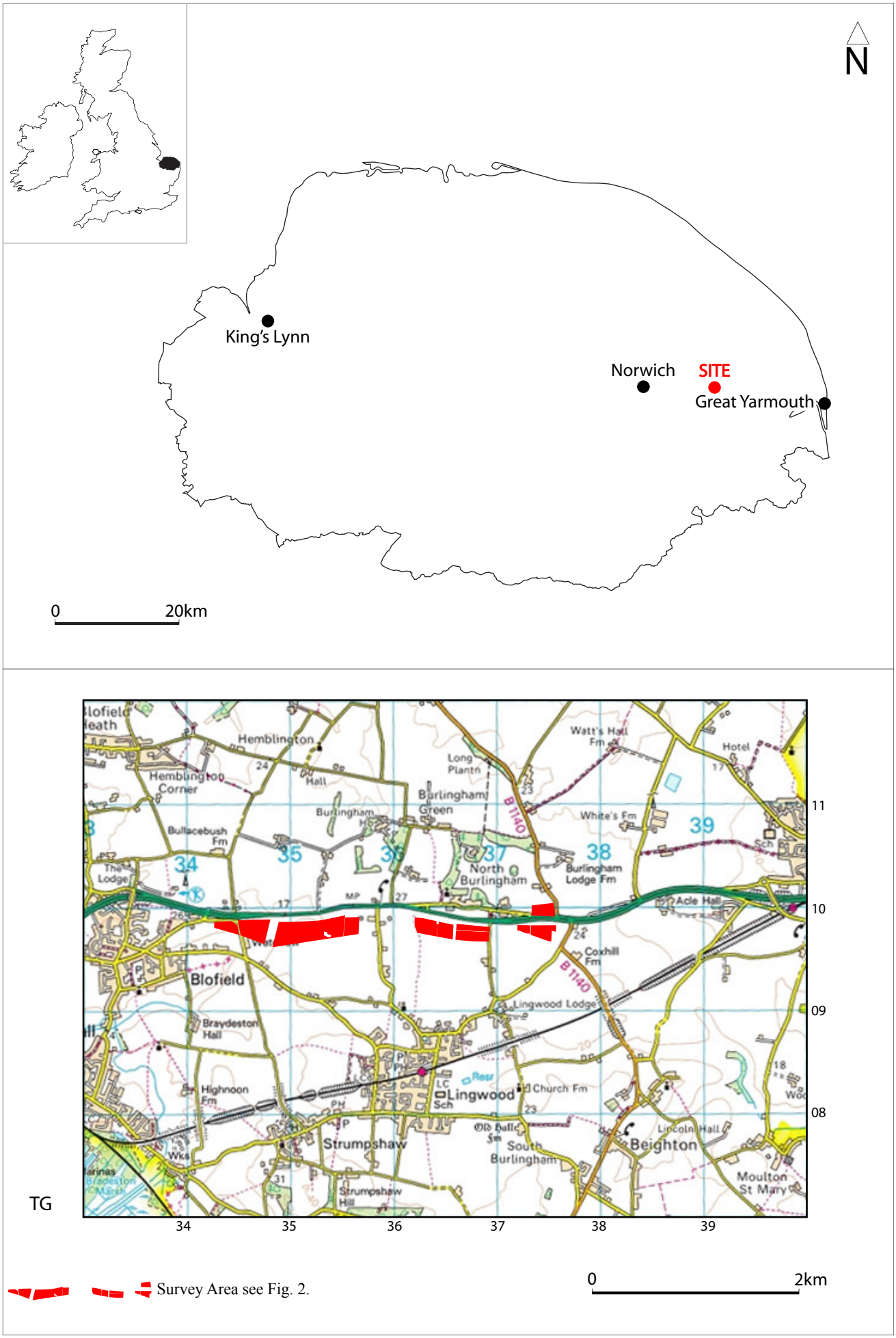


Fig. 1. Site location

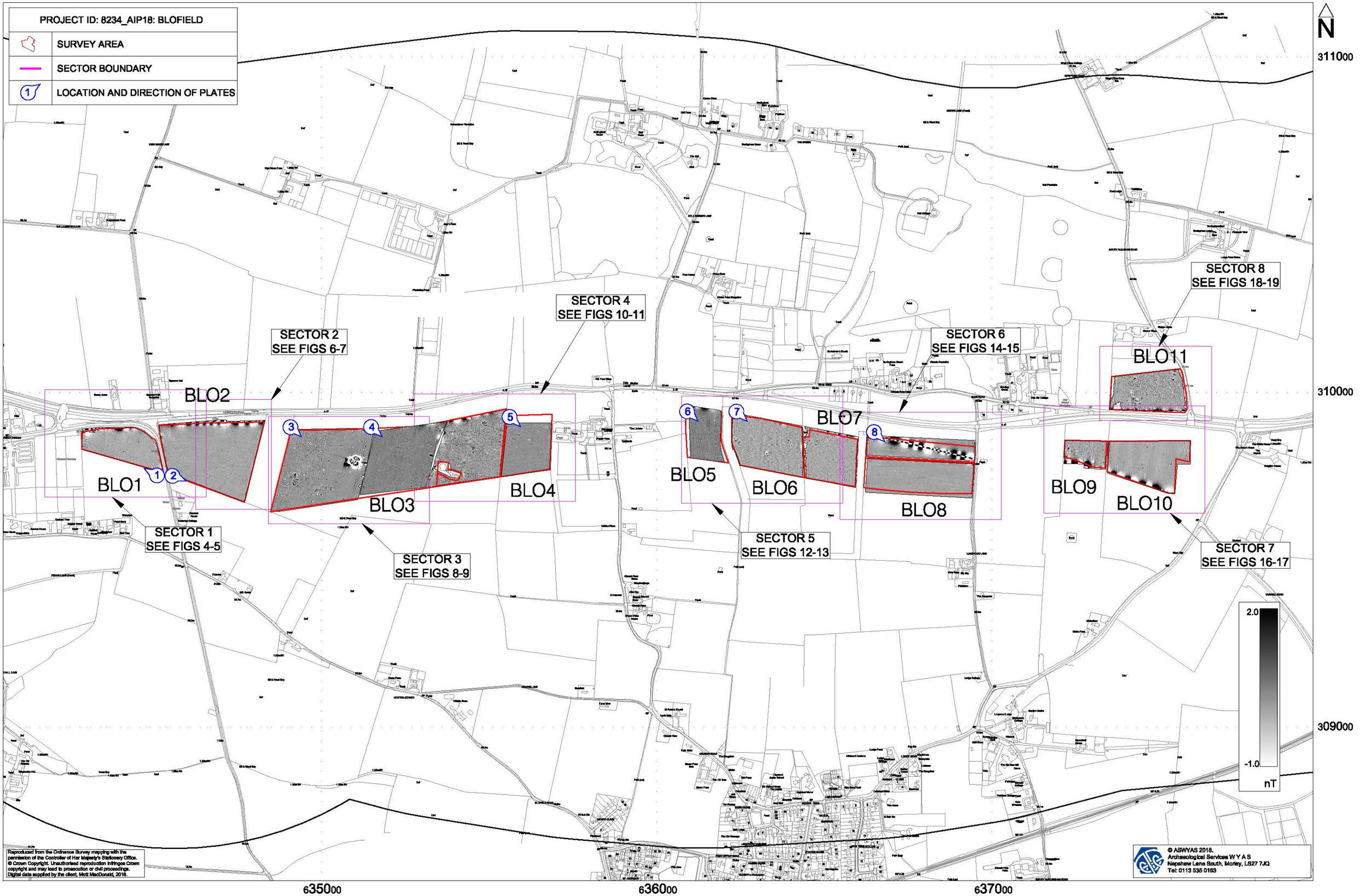


Fig. 2. Overall greyscale of magnetometer data (1:10000 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD	
	SURVEY AREA
	CROPMARK DATA
	SECTOR BOUNDARY

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY?
	LINEAR TREND	ARCHAEOLOGY?

N

311000

310000

309000

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

BLO1

BLO2

BLO3

BLO4

BLO5

BLO6

BLO7

BLO8

BLO9

BLO10

BL11

49444

49445

49446

49453

49454

49463

45150

45149

18130

49456

49455

49457

35519

45143

49447

49635

49614

49613

12783

49575

49688

49569

49612

635000 636000 637000

0 500m

Fig. 3. Overall interpretation of magnetometer data, including client supplied cropmark data (1:10000 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

Sunny Acres

Sparrow Hall Bungalow

N

310000

24.7m

20.8m

2.0

-1.0

nT

Allotment Gardens

BLO1

309800

Brienz

634200

634400

634600

0 50m

Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)

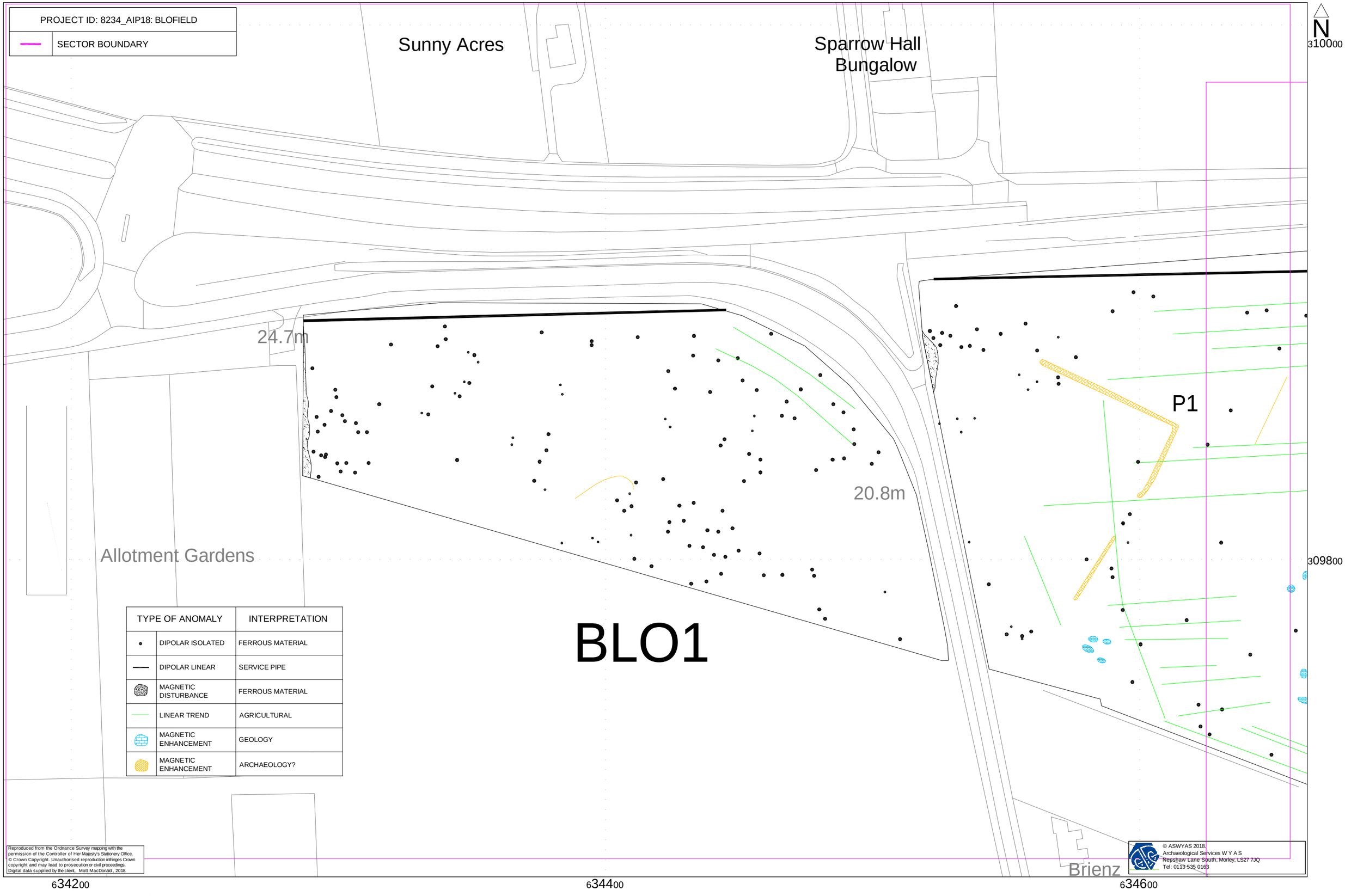


Fig. 5. Interpretation of magnetometer data; Sector 1 (1:1250 @ A3)

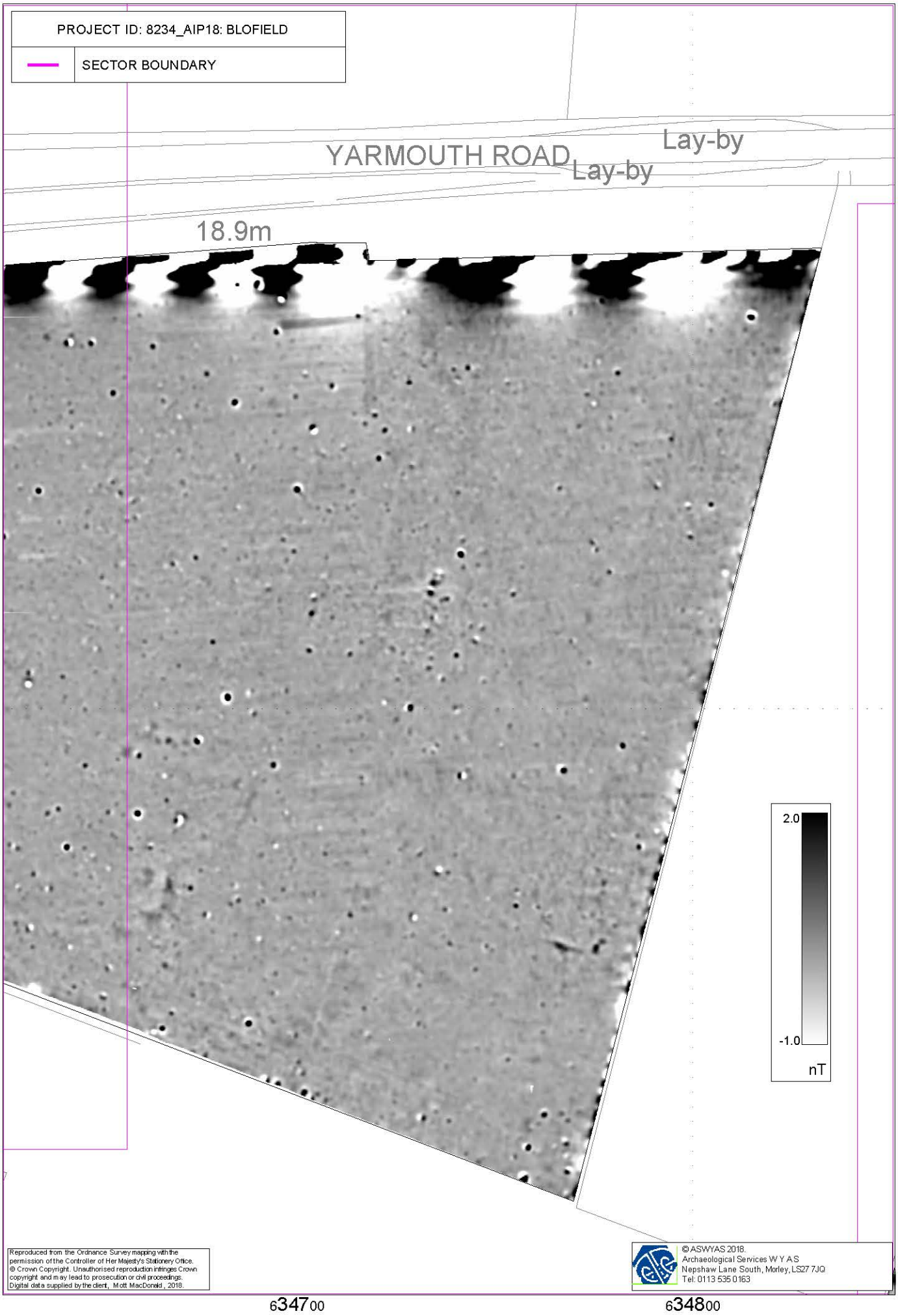


Fig. 6. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A4) 0 50m

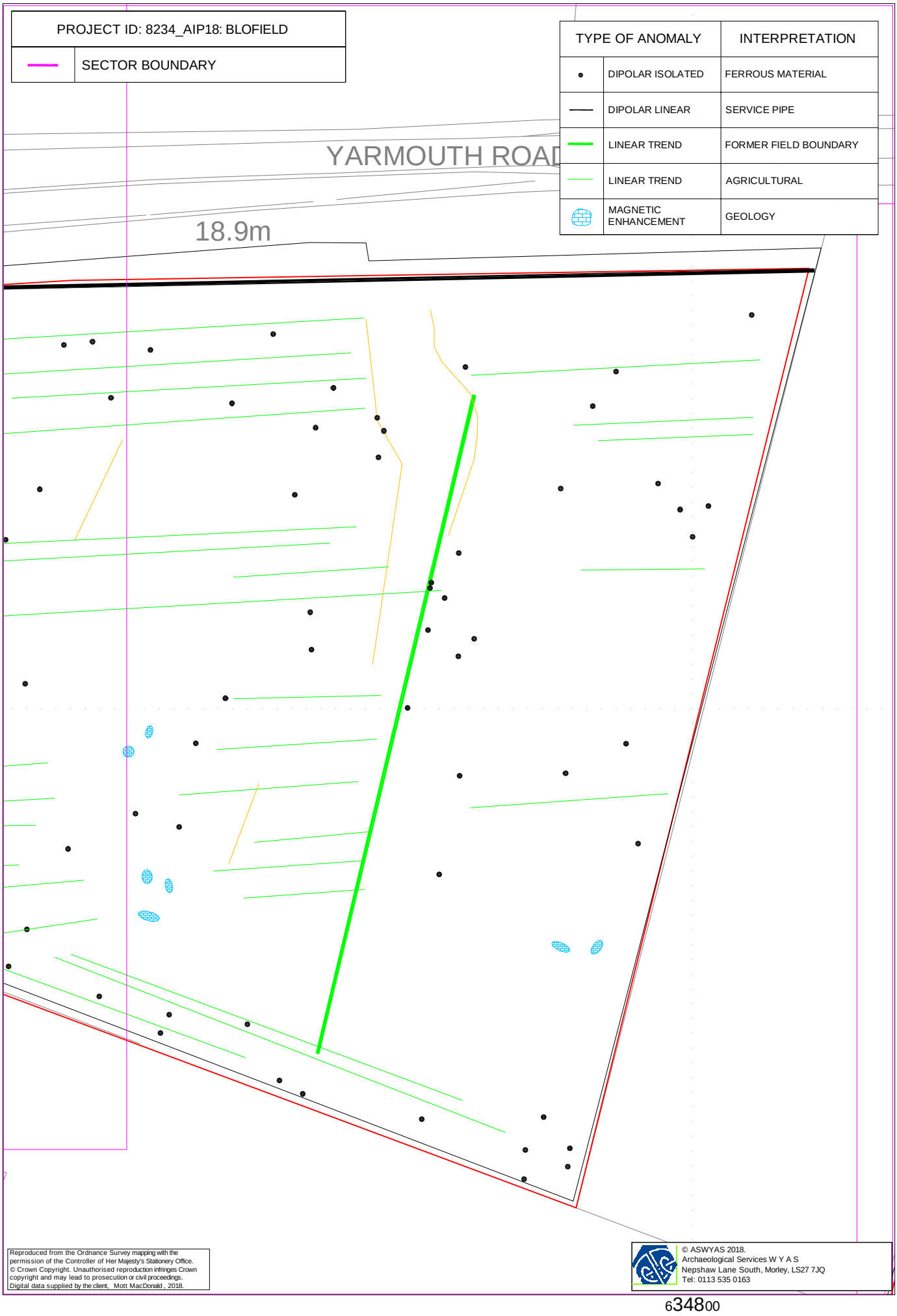


Fig. 7. Interpretation of magnetometer data; Sector 2 (1:1250 @ A4)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

19.2m

N

309800

2.0

-1.0

nT

ED & Ward Bdy

Archaeological Services W Y A S
Napshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0163

6350 00

6352 00

0 50m

Fig. 8. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

19.2m

N

Def

309800

nT

ED & Ward Bdy

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0163

635000

635200

0 50m

Fig. 9. Interpretation of magnetometer data; Sector 3 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

N

Tanks

Pond

Pond

Ponds

2.0

-1.0

nT

309800

354000

356000

0 50m

Reproduced from the Ordnance Survey mapping with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Digital data supplied by the client, Mott MacDonald, 2018.

Fig. 10. Processed greyscale magnetometer data; Sector 4 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD	
—	SECTOR BOUNDARY

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
—	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY

N

CK

Tanks

Pon

Pond

Ponds

nT

309800

635400

635600

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0163

0 50m

Fig. 11. Interpretation of magnetometer data; Sector 4 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

27.1m

N

Lay-

Pond

309800

2.0

-1.0

nT

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0183

6362 00

6364 00

0 50m

Fig. 12. Processed greyscale magnetometer data; Sector 5 (1:1250 @ A3)

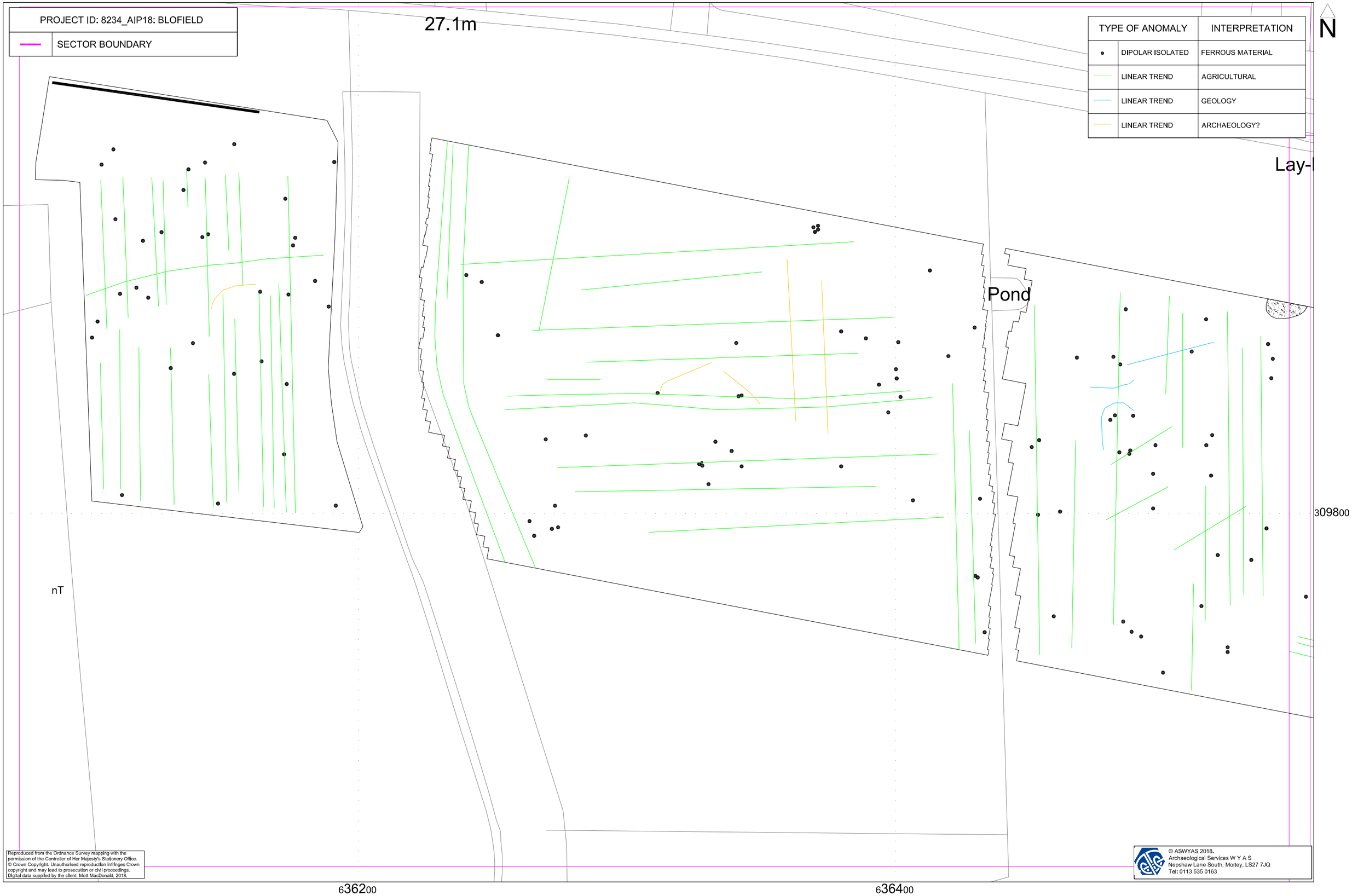


Fig. 13. Interpretation of magnetometer data; Sector 5 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

18

N

309800

26.0m

Pond

2.0

-1.0

nT

BLO8

Archaeological Services WYAS
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0163

636600

636800

637000

0 50m

Fig. 14. Processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

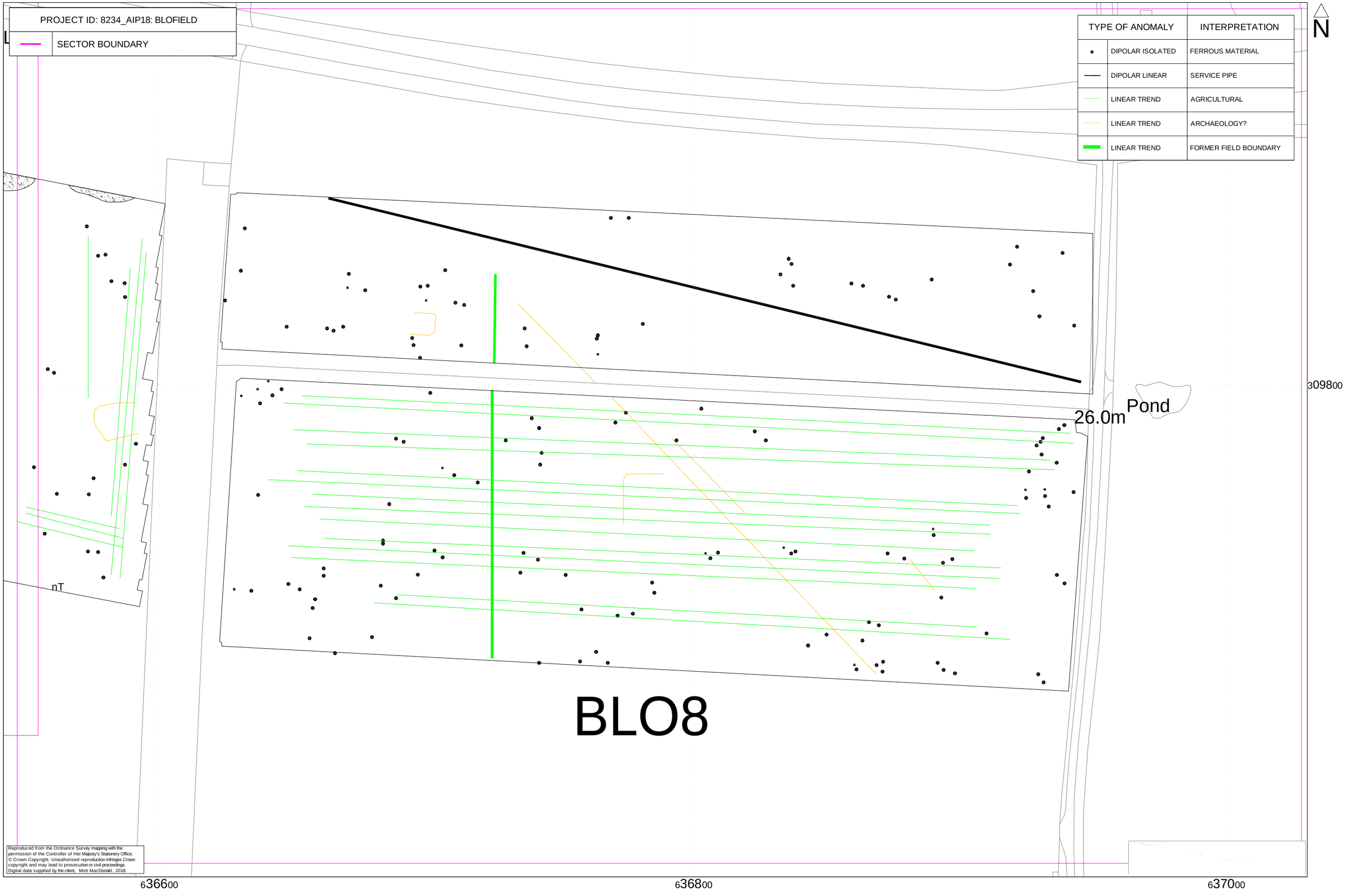


Fig. 15. Interpretation of magnetometer data; Sector 6 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

MP

N

BLO9

BLO10

2.0

-1.0

nT

309800

6372 00

6374 00

6376 00

0 50m

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 535 0163

Fig. 16. Processed greyscale magnetometer data; Sector 7 (1:1250 @ A3)

PROJECT ID: 8234_AIP18: BLOFIELD

SECTOR BOUNDARY

MP

N

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	AGRICULTURAL
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	GEOLOGY

BLO9

BLO10

309800

6372 00 6374 00 6376 00

0 50m

Fig. 17. Interpretation of magnetometer data; Sector 7 (1:1250 @ A3)

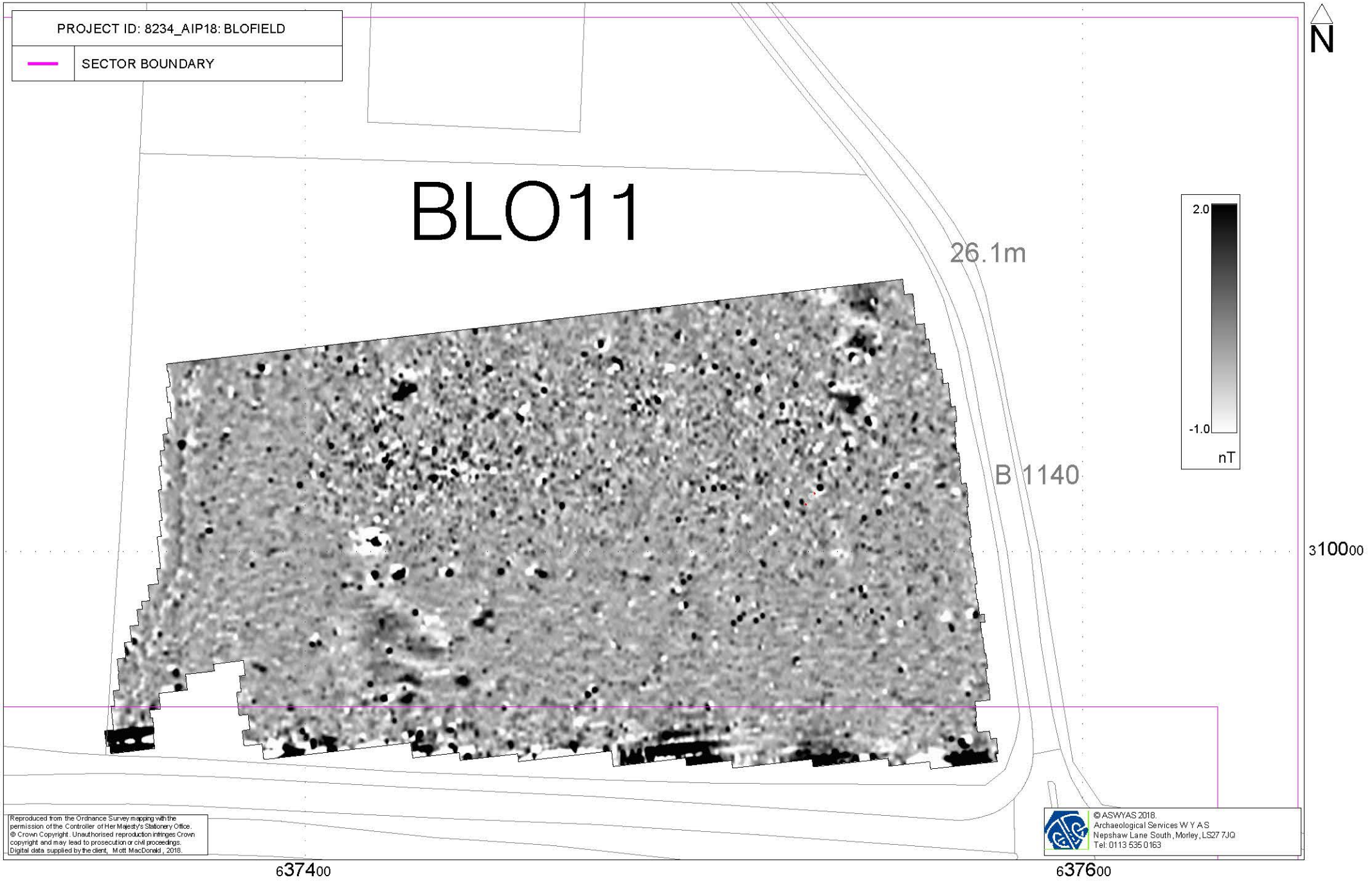


Fig. 18. Processed greyscale magnetometer data; Sector 8 (1:1250 @ A4)

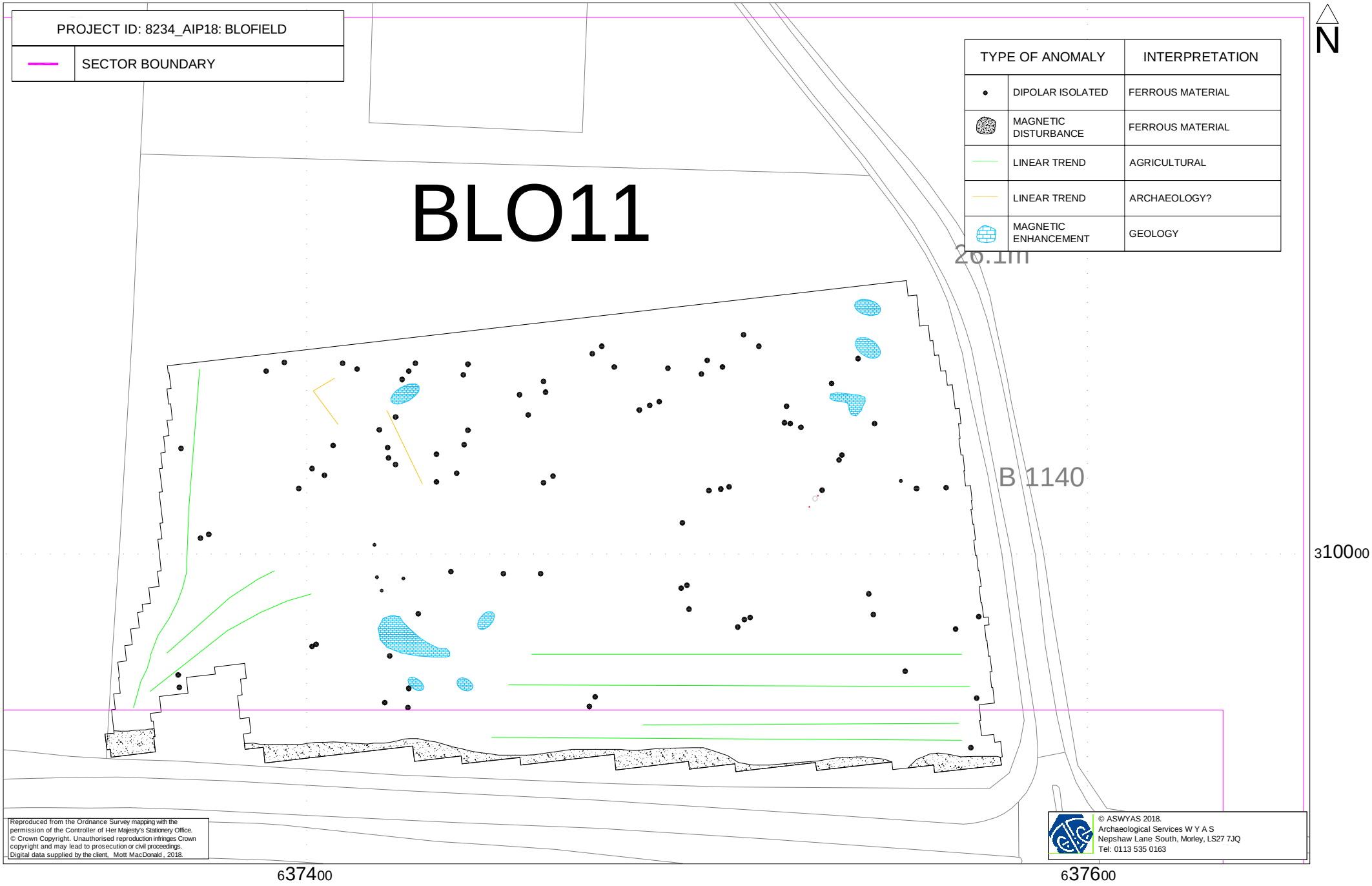


Fig. 19. Interpretation of magnetometer data; Sector 8 (1:1250 @ A4)

Plate 1. General view of BLO1, facing northwest.

Plate 2. General view of BLO2, facing southeast.

Plate 3. General view of BLO3A, facing southeast.

Plate 4. General view of BLO3B, facing southeast.

Plate 5. General view of BLO4, facing southeast.

Plate 6. General view of BLO5, facing southeast.

Plate 7. General view of BLO6, facing southeast.

Plate 8. General view of BLO8, facing southwest.

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 a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 0.5m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

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.

In addition, parts of the magnetometer survey were undertaken using a Sensys Magneto MXPDA cart-based instrument. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20Hz. The gradiometers have a range of recording between 0.1nT and 10,000nT. They are linked to a Trimble R6 RTK dGPS system with data recorded by Sensys Magneto MXPDA software on a rugged PDA device. The data was stored on an SD memory card within the PDA and later downloaded to a computer for processing and interpretation. MAGNETO (Sensys Gmbh) software was used to process and present the data

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in processed greyscale format. The data in the greyscale images has 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.

MAGNETO was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits

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 CS6 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 Norfolk Historic Environment Record).

Appendix 4: Oasis form

OASIS DATA COLLECTION FORM: England

List of Projects | Manage Projects | Search Projects | New project | Change your details | HER coverage | Change country | Log out

Printable version

OASIS ID: archaeol11-321596

Project details

Project name	Blofield to North Burlingham, A47, Norfolk
Short description of the project	A hand-held and cart-based geophysical (magnetometer) survey, covering approximately 40.6 hectares was undertaken on land to the south of the A47 between Blofield and North Burlingham. Approximately 5.5 hectares were unsuitable for survey. Anomalies of a possible archaeological origin have been recorded in the western and eastern portions of the corridor. A former field boundary has also been detected in the eastern part of the site which corresponds well with recorded boundaries on Ordnance Survey mapping. Ferrous and magnetic disturbance anomalies, along with evidence of a service pipe along the northern edge of the survey corridor, have been detected. Responses associated with a former sand pit are present. The archaeological potential of the site would be characterised as medium to low.
Project dates	Start: 19-03-2018 End: 29-03-2018
Previous/future work	Not known / Not known
Any associated project reference codes	AIP18 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Not recorded
Prompt	Environmental (unspecified schedule)
Position in the planning process	Not known / Not recorded
Solid geology (other)	Crag Group sand and gravel

Drift geology (other)	Lowestoft formation
Techniques	Magnetometry

Project location

Country	England
Site location	NORFOLK NORWICH NORWICH Blofield to North Burlingham, A47
Postcode	NR13 4AH
Study area	40.6 Hectares
Site coordinates	TG 343 098 52.63474787707 1.463022601138 52 38 05 N 001 27 46 E Point
Site coordinates	TG 376 098 52.633303394338 1.511698668188 52 37 59 N 001 30 42 E Point
Height OD / Depth	Min: 15m Max: 26m

Project creators

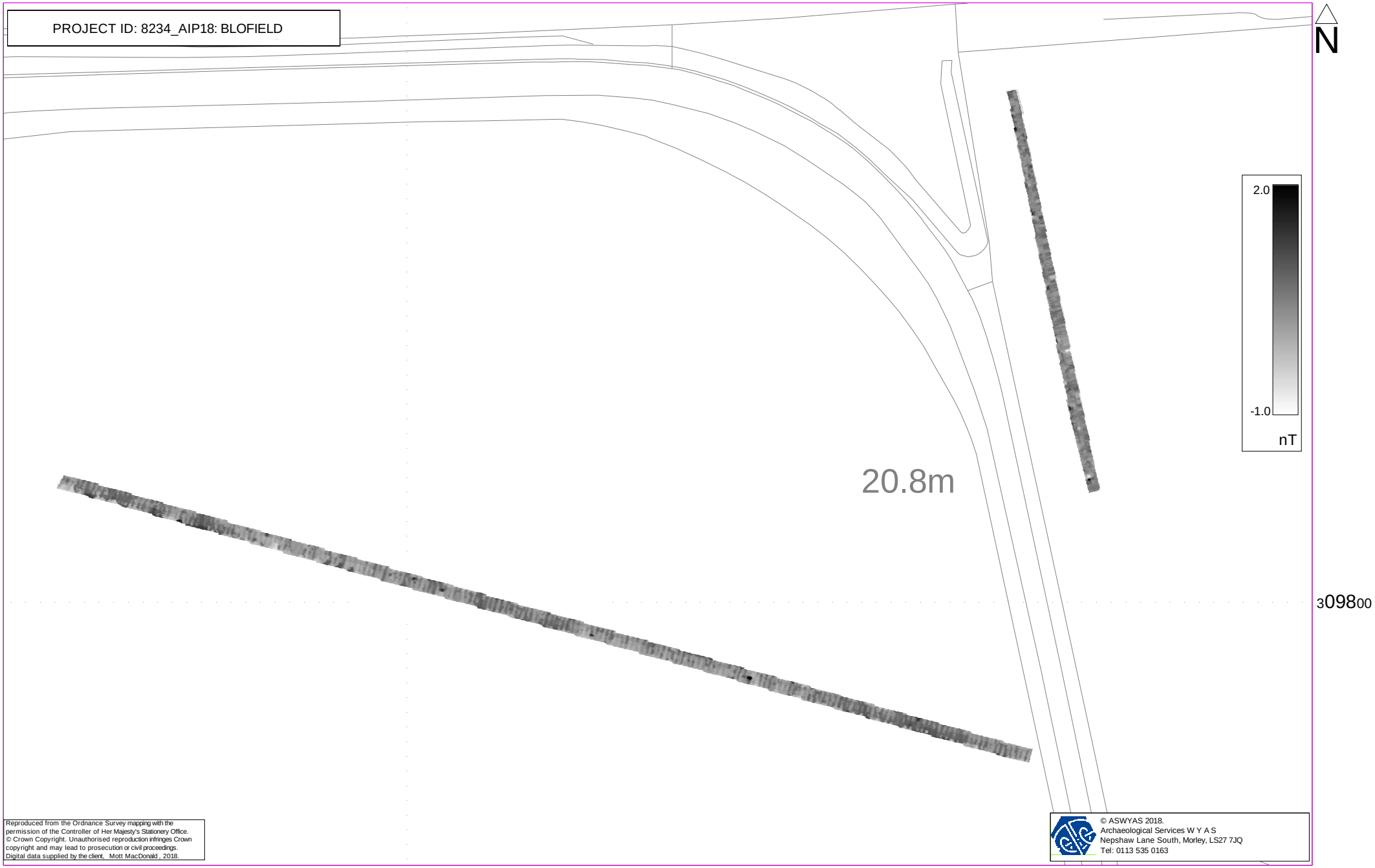
Name of Organisation	Archaeological Services WYAS
Project brief originator	Mott MacDonald
Project design originator	ASWYAS
Project director/manager	E. Brunning
Project supervisor	C. Sykes

Project archives

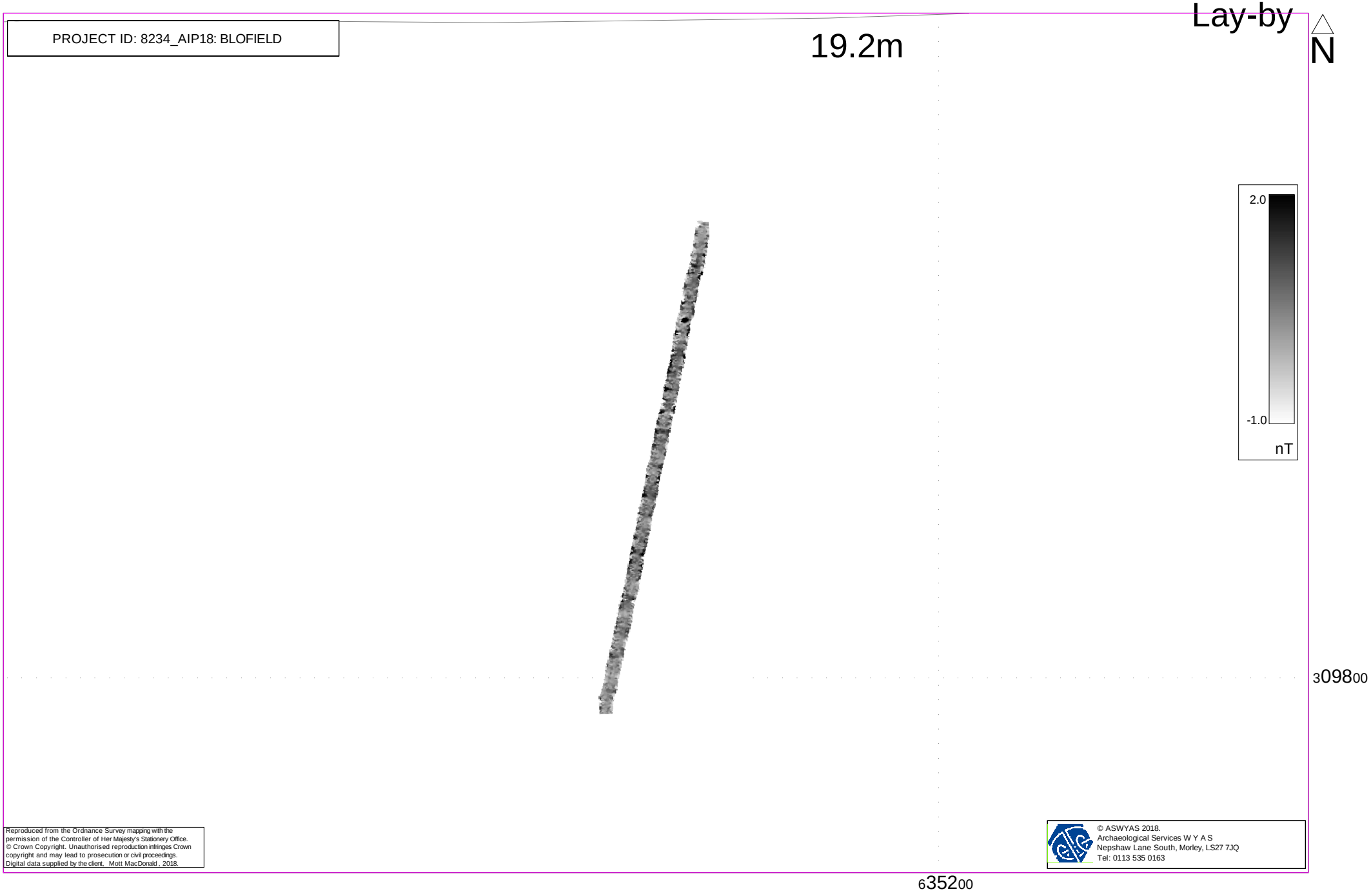
Physical Archive Exists?	No
Digital Archive recipient	ASWYAS
Digital Contents	"none"
Digital Media available	"Geophysics","Survey","Text"
Paper Archive Exists?	No

Entered by	J. Ranaldi (jamie.ranaldi@aswyas.com)
Entered on	5 July 2018

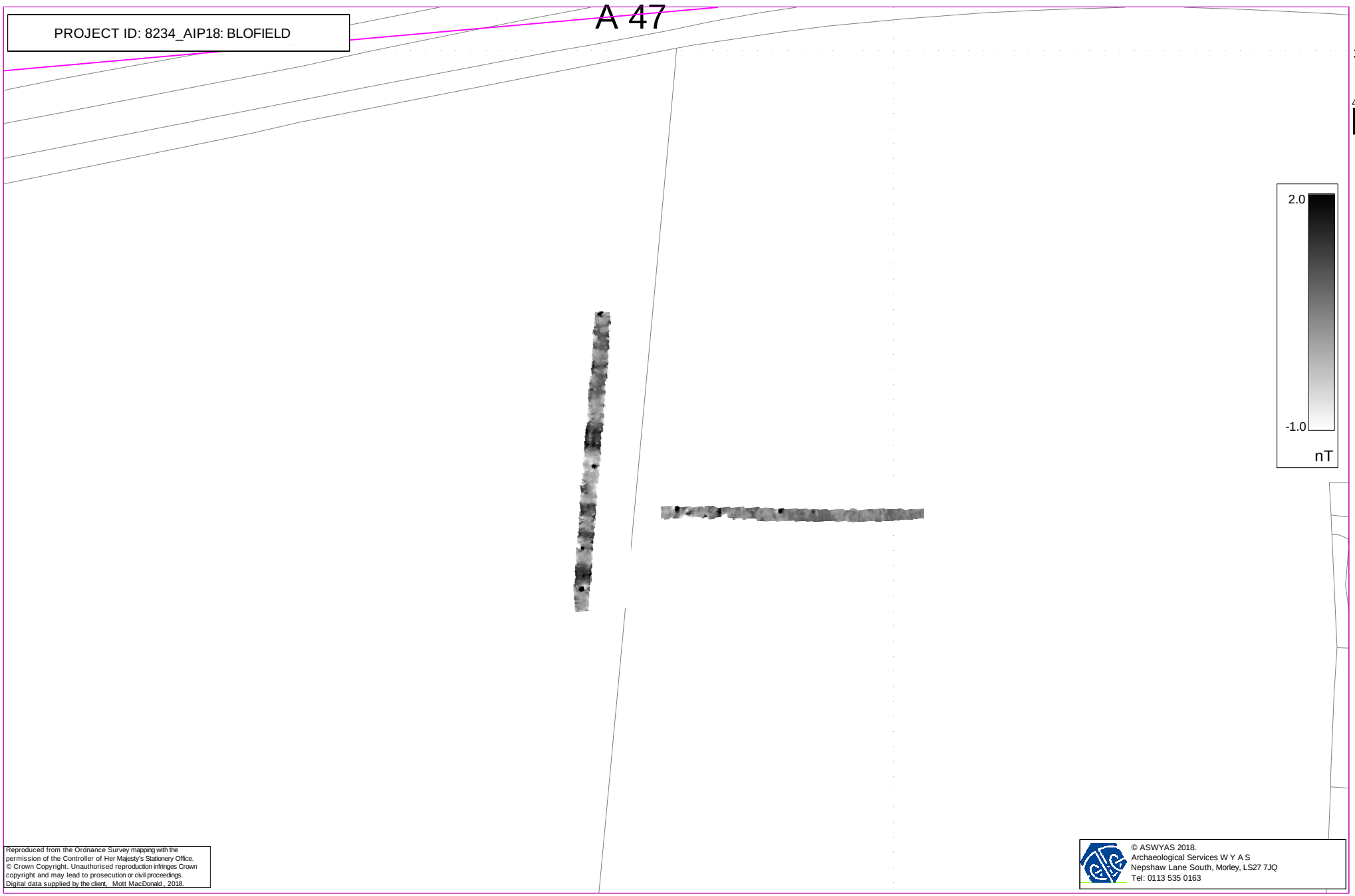
Appendix 5: Repeat tracks / grids



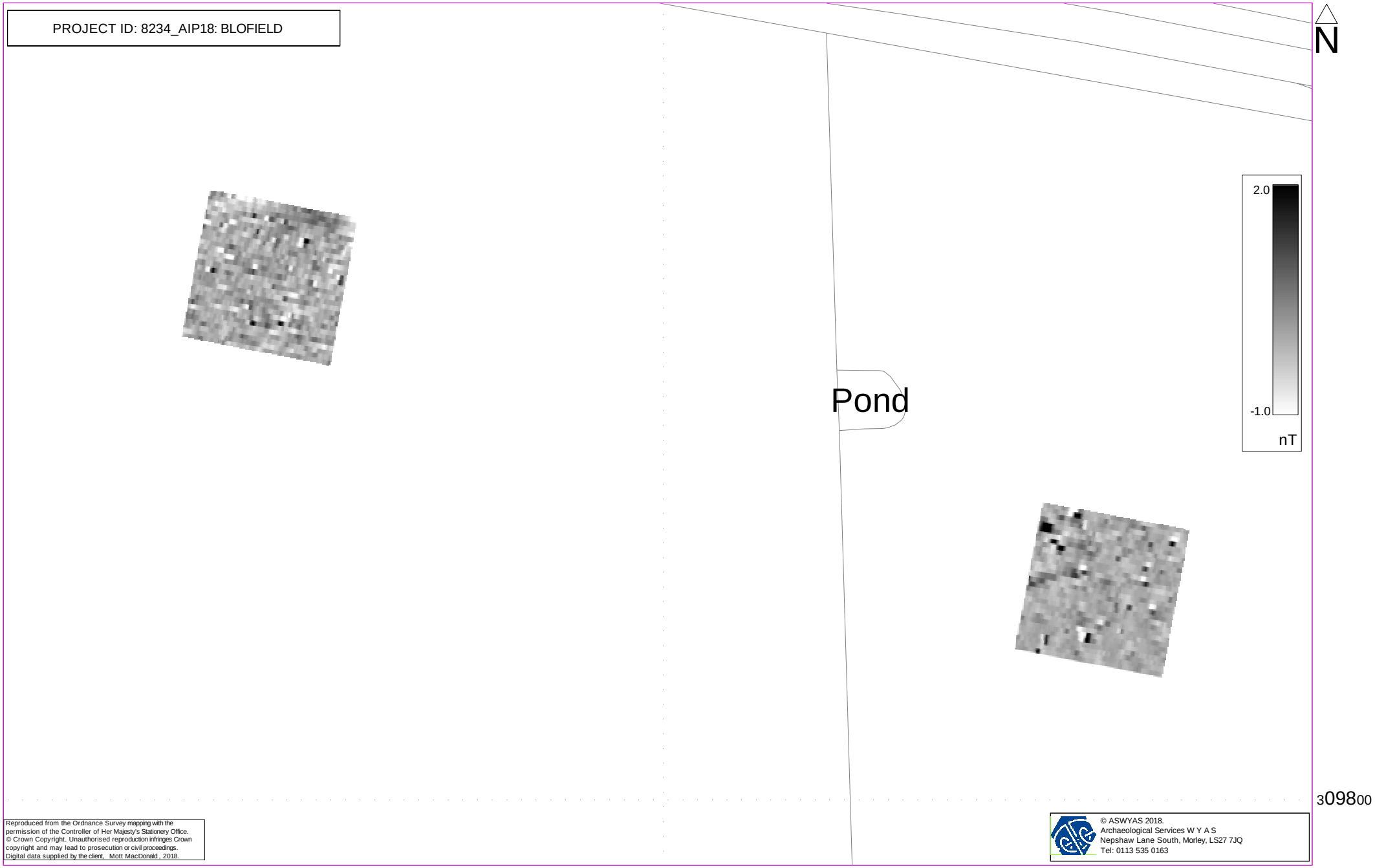
Appendix 5. Repeat track; Area 1 (west) and Area 2 (east) (1:1000 @ A4)



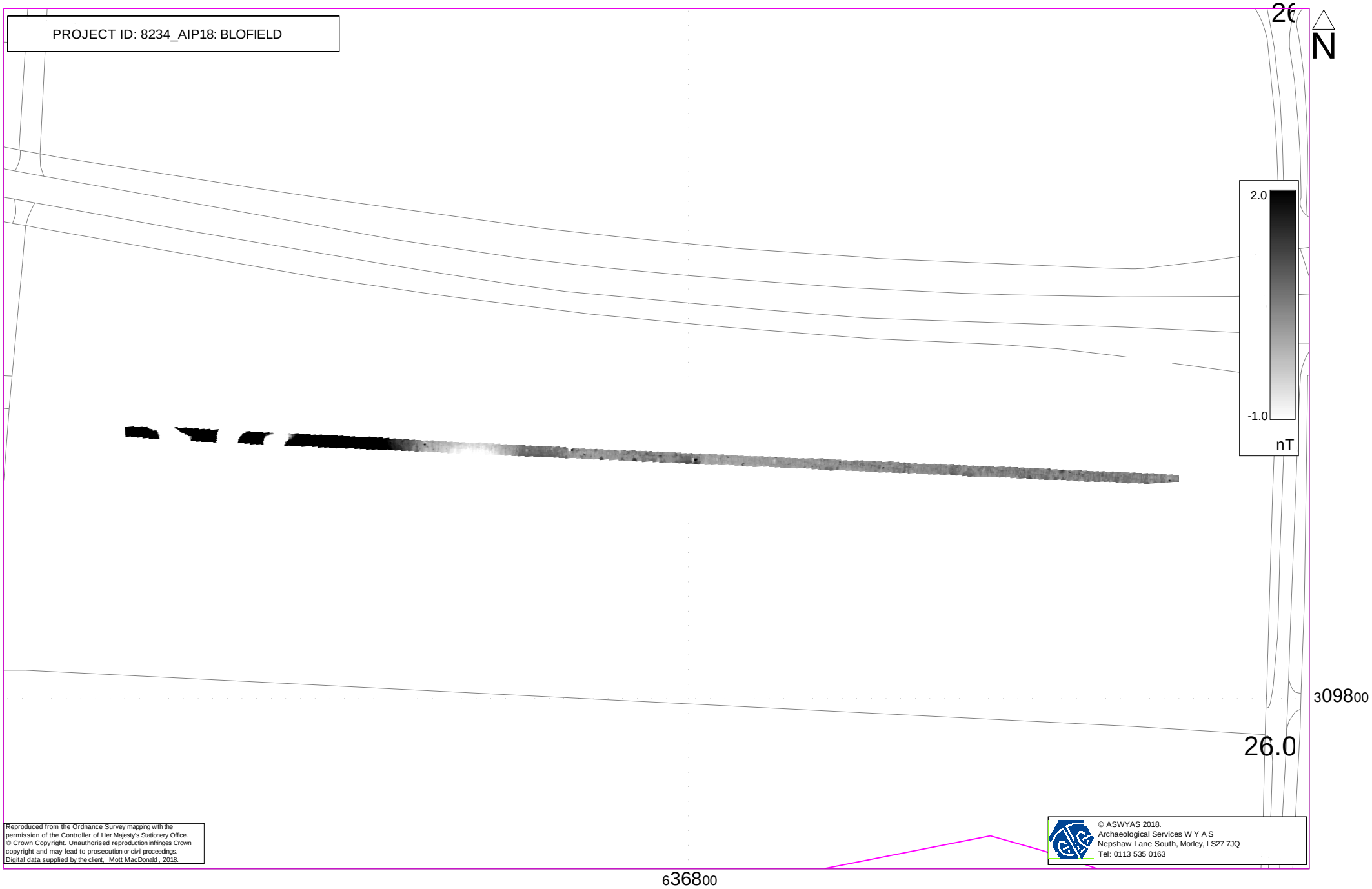
Appendix 5. Repeat track; Area 3a (1:1000 @ A4)



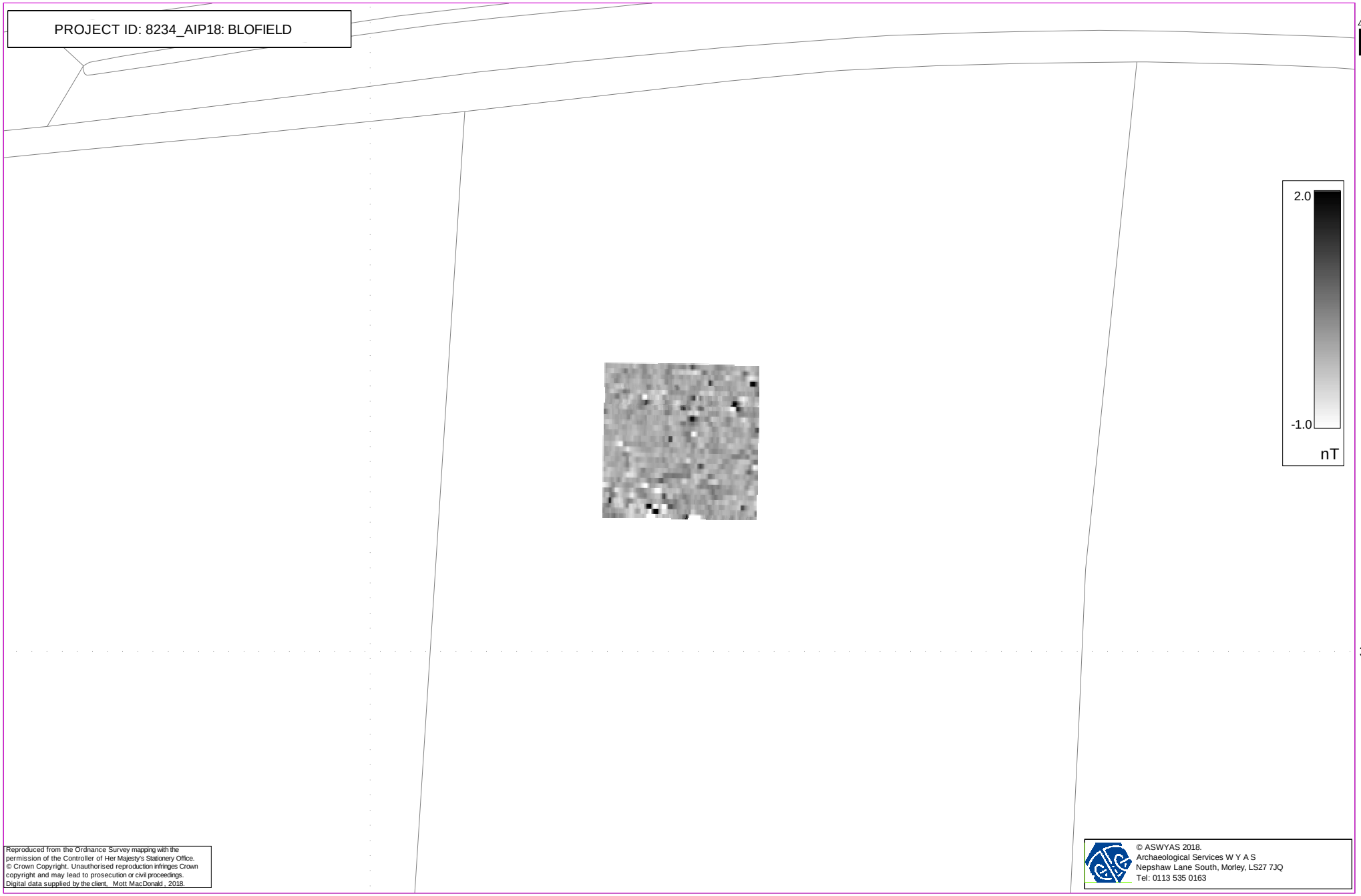
Appendix 5. Repeat tracks; Area 3c (west) and Area 4 (east) (1:1000 @ A4)



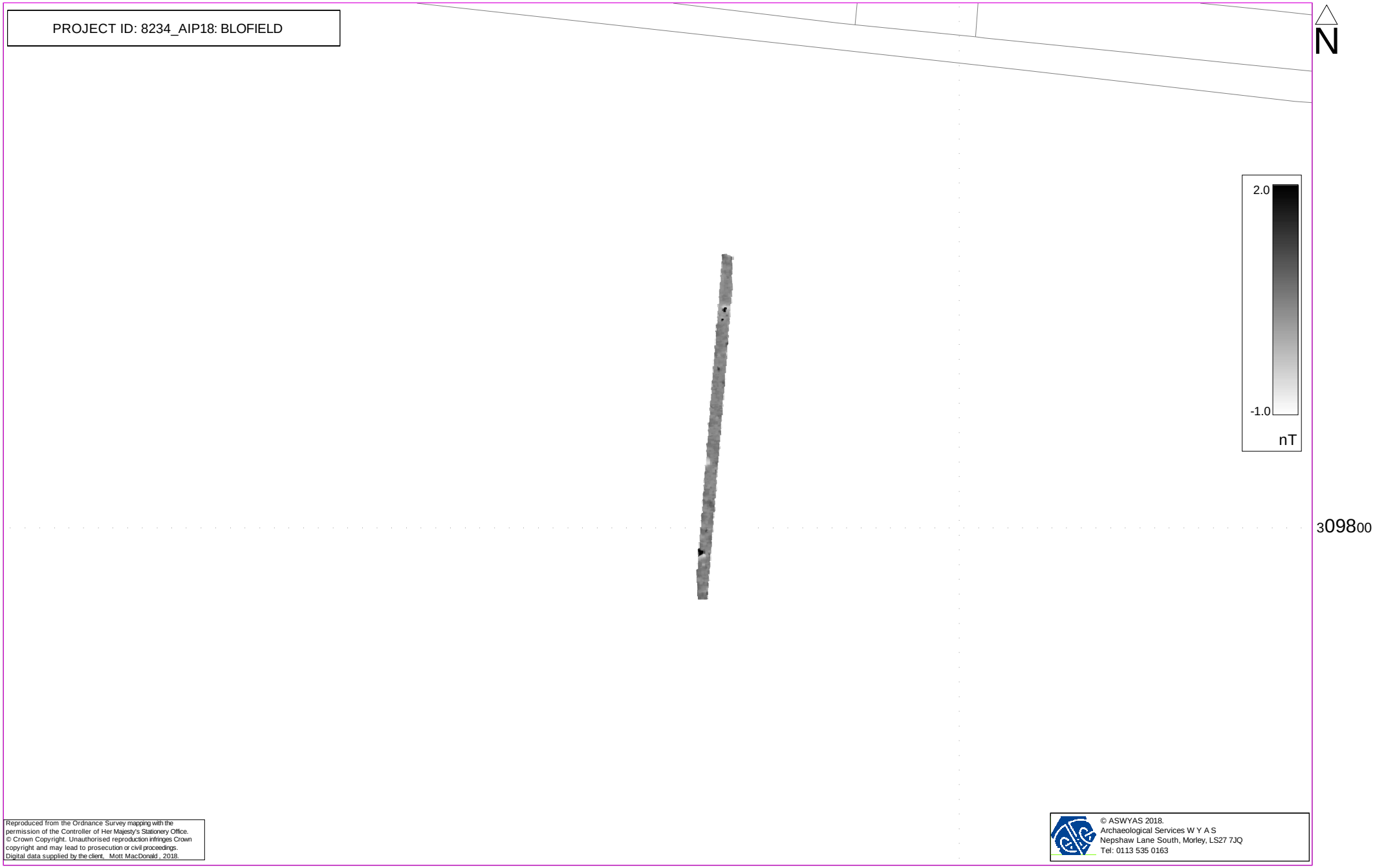
Appendix 5. Repeat grids; Area 6 (west) and Area 7 (east) (1:1000 @ A4)



Appendix 5. Repeat track; Area 8 (1:1250 @ A4)



Appendix 5. Repeat grid; Area 9 (1:1000 @ A4)



Appendix 5. Repeat track; Area 10 (1:1000 @ A4)

Bibliography

British Geological Survey, 2018. http://mapapps.bgs.ac.uk/geologyofbritain/home.html (viewed April 2018)

CIfA, 2014. *Standard and Guidance for Archaeological Geophysical Survey.* Chartered Institute for Archaeologists

David, A., N. Linford, P. Linford and L. Martin, 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* Historic England

DCLG, 2012. *National Planning Policy Framework*. Department of Communities and Local Government

Gaffney, C. and Gater, J., 2003. *Revealing the Buried Past: Geophysics for Archaeologists* Tempus Publishing Ltd

Highways England, 2018. *A47 Improvement Programme Archaeological Specification for Geophysical Survey. HETUDHAM-MMSJV-EHR-000-SH-LX-00001*. January 2018

OM, 2018. www.old-maps.co.uk (viewed June 2018)

SSEW, 1983. Soils of Northern England, Sheet 1. Soil Survey of England and Wales