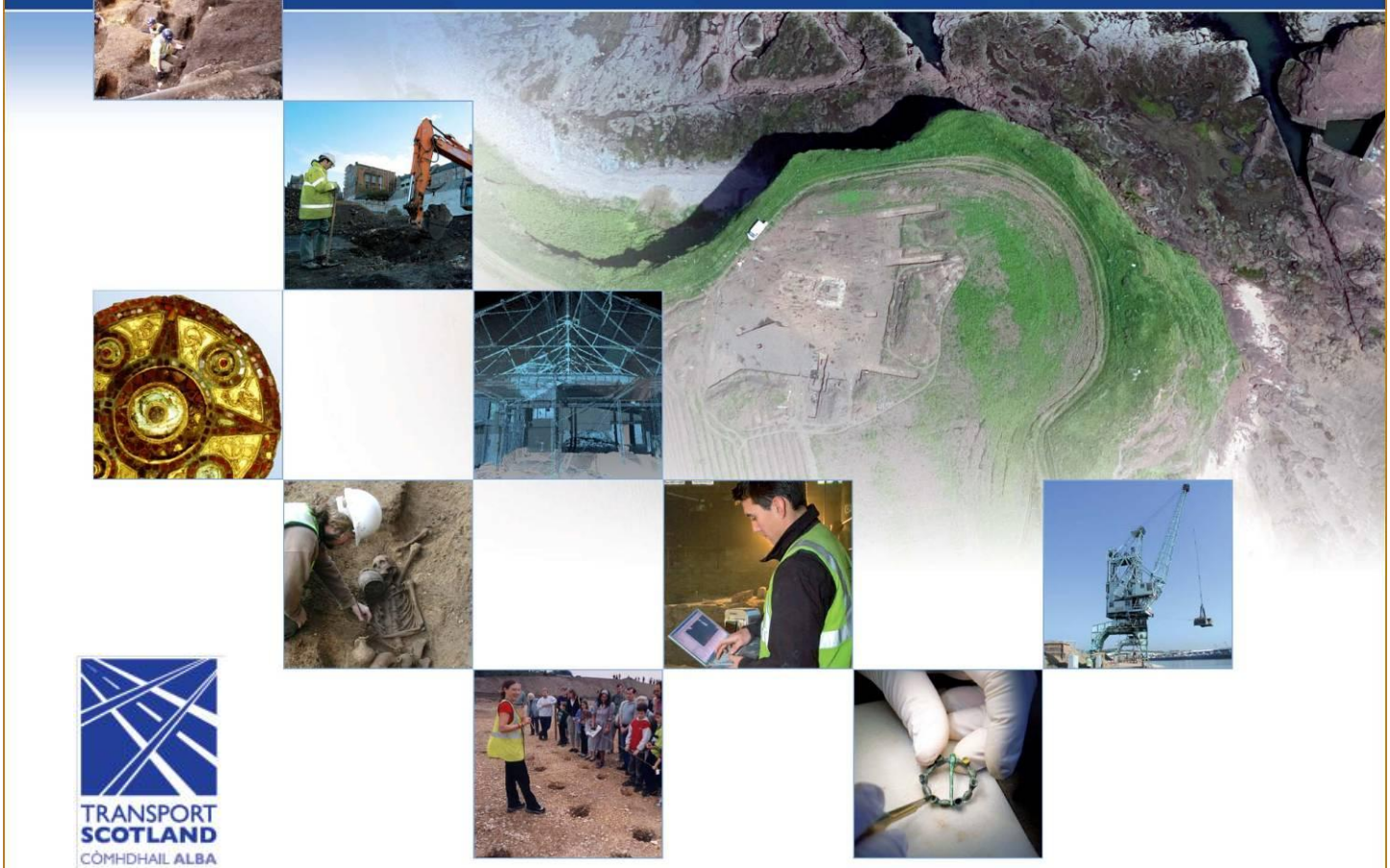
A9 Dualling Programme, Pass of Birnam to Glen Garry, Scotland

Archaeological Geophysical Survey

National Grid Reference Number: NN 89629 64150

AOC Project No: 51640

Date: November 2016



TRANSPORT SCOTLAND
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A9 DUALLING
PERTH TO INVERNESS

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A9 Dualling Programme,
Pass of Birnam to Glen Garry, Scotland
Archaeological Geophysical Survey

On Behalf of: 95 Bothwell Street,
Glasgow,
Scotland,
G2 7HX,
United Kingdom

National Grid Reference (NGR): NN 89629 64150

AOC Project No: 51640

Prepared by: James Lawton and Alistair Galt

Illustrations by: Kimberley Teale

Date of Survey: 14th November 2016 – 18th November 2016

This document has been prepared in accordance with AOC standard operating procedures.

Author: James Lawton	**Date: 1st December 2016**
Approved by: Graeme Cavers	**Date: 1st December 2016**
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Enquiries to: AOC Archaeology Group
The Raylor Centre
James Street
York
YO10 3DW

Tel. 01904 413404
e-mail. york@aocarchaeology.com

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Non-Technical Summary

AOC Archaeology Group was commissioned by Jacobs to undertake an archaeological geophysical (gradiometer) survey to investigate the potential for buried archaeological remains on the proposed A9 Dualling Programme, from Killiecrankie to Glen Garry (centred at NN 89629 64150*).*

The designated survey corridor covered seven parcels of land totalling approximately 10 hectares, of which four fields consisted of sheep pasture, one of overgrown vegetation, and two of short grass and vegetation with no livestock.

The topography of the parcels were for the most part gradual to steep south facing slopes in the eastern fields (Parcels 1, 2, 3 and 4) and mostly level on the three westernmost fields (Parcels 5, 6 and 7). Parcels 6 and 7 contained visible earthworks of possible archaeological interest and these have been recorded as part of the geophysical results.

The results of the survey were relatively good, in particular Parcel 7 revealed a number of geophysical anomalies that are likely to relate to settlement.

A number of discrete linear geophysical anomalies were located throughout the survey parcels that could be of an archaeological origin, particularly those identified in Parcel 6. However these are only tentative and no clear pattern has been detected and only further evaluation will ascertain the origin of these anomalies.

A number of pit like anomalies were detected in Parcel 3 which although are likely to be related to geological processes, could potentially be linked to the site of a battlefield known to have been in close proximity to the survey parcel.

Throughout all of the parcels a number of geological responses have been detected. These are likely all related to geological changes as the background geology is known to have strong magnetic signal strengths.

An anomaly relating to a pipe was located in Parcel 3, and a number of upstanding boreholes were also reflected in the results of a number of parcels, which although avoided at the time of survey, were still close enough to be detected by the machines. A number of isolated ferrous spikes were detected in all the parcels which are likely to be the result of modern manuring or debris over the land.

1 Introduction

1.1 AOC Archaeology Group was commissioned by Jacobs UK Limited (Jacobs) to undertake an archaeological geophysical survey of the proposed Dualling of the A9 between the Pass of Birnam and Glen Garry. This is part of a wider scheme of archaeological assessments to inform the DMRB Stage 3 environmental assessment of the proposed Scheme.

1.2 The survey was carried out to provide information on the extent and significance of any potential buried archaeological remains within the proposed development site.

2 Site Location and Description

2.1 The designated survey corridor was located over 7 parcels of mixed pasture and fallow land within existing fields bordering the current A9. The route runs between Killiecrankie in the east and Dalnamein Lodge to the west, with most of the surveys occurring between Killiecrankie and Blair Atholl. The site is centred at NN 89629 64150 (see Figure 1).

2.2 The site ranges from 130m and 250m aOD, predominately between 130m and 160m aOD. The recorded bedrock geology within the site is mostly Killiecrankie Schist Formation-Semipelite and Micaceous Psammite, with Blair Atholl Dark Limestone and Dark Schist Formation-Metalimestone, Gaick Psammite Formation-Psammite, Tummel Psammite Formation-Psammite and Flaggy Semipelite and Tummel Quartzite Formation-Quartzite. The superficial geology is a mixture of Alluvium, Devensian Till-Diamicton and Hummocky (moundy) Glacial Deposits-Diamicton, Sand and Gravel [unlithified] (BGS 2016). These are overlain by Humus-iron podzols and Brown earths (Scotland's Soils 2016).

2.3 Gradiometer survey is suggested to provide a good response over limestones and metamorphic rocks, although adjacent intrusions need to be noted. However, the overlying drift geology may be variable, with the normal response being average to poor over alluvium, while it is moderate to good on sands and gravels (David *et al.* 2008).

2.4 The proposed development site is bounded by the A9 in Parcels 1, 3 and 4 on the north side, and on the south side of Parcel 2. These parcels vary from a slight slope to very steep. They are for the most part pasture land except for Parcel 2 which is overgrown vegetation. Parcel 5 is a relatively flat pasture area, with fencing on the eastern and western extents. Parcels 6 and 7 have a large cycle path adjacent to their northernmost boundaries and have slight to moderate vegetation and pasture, with slopes that are unsurveyable.

3 Archaeological Background

3.1 The archaeological background below is drawn from the Specification for Archaeological Geophysical Survey (Jacobs 2016). A desk-based assessment of the history of the site will be written in due course.

3.2 There are several cultural heritage assets scattered over the proposed development, including Duns, possible barrows and surviving buildings in Killiecrankie and surrounding farmsteads (CANMORE 2016, Jacobs 2016). Killiecrankie Battlefield is located within the survey area and there is a monument associated with the battle (Jacobs 2016). Many of these monuments are undated.

3.3 An undated cairn is located in Parcel 1, known as Old Faskally. Its shape and form suggests a prehistoric date but this is not certain.

3.4 Two “castles” are known to the south of Parcel 5, partly demolished by the modern A9 (asset 362). These are believed to be Prehistoric / Iron Age in date. These Duns are also associated with ramparts and ditches of the same age.

3.5 The Killiecrankie Battlefield Inventory boundary covers Parcels 1 through to 5, and a number of monuments related to this are scattered in the vicinity of each parcel.

4 Aims

4.1 The aim of the geophysical survey was to identify any potential archaeological anomalies that would inform and support the cultural heritage chapter of the Environmental Statement for Project 05: Killiecrankie to Glen Garry, and assist in the assessment of the magnitude of impact on heritage.

4.2 Specifically the aims of the gradiometer survey were:

- to determine (so far as possible) the presence or absence of buried archaeological remains in the survey parcels;
- to clarify the extent and layout of known sites of archaeological interest within the survey parcels;
- to clarify the extent and layout of previously unknown buried remains within the survey parcels;
- to interpret any geophysical anomalies identified by the survey; and
- disseminate the results of the archaeological geophysical survey through the deposition of an ordered archive and detailed report at the National Record of the Historic Environment (NRHE).

5 Methodology

5.1 Parameters were selected that were suitable for the prospective aims of the survey and in accordance with recommended professional good practice (David *et al.* 2008, 8).

5.2 The gradiometer survey was carried out using Bartington Grad601-2 fluxgate gradiometers (see Appendix 1 and 2). Data was collected on an east-west alignment using zig-zag traverses, with a sample interval of 0.25m and a traverse interval of 1m.

5.3 A total of 163 full or partial 30m by 30m grids were surveyed within the proposed site, totalling a surveyed area of approximately 10ha. Attention was taken to attempt to avoid metal obstacles present within the survey area. Gradiometer survey is affected by ‘above-ground noise’ and therefore avoiding metallic objects improves the overall data quality and results obtained.

5.4 All geophysical survey work was carried out in accordance with recommended good practice specified in guideline documents published by English Heritage (David *et al.* 2008), and the Chartered Institute for Archaeologists *Standard and Guidance for archaeological geophysical survey* (2014). Data processing, storage and documentation were carried out in accordance with the good practice specifications detailed in the guidelines issued by the Archaeology Data Service (Schmidt and Ernenwein 2011). An online OASIS entry will be created, and a summary of the results submitted to Archaeology Scotland’s annual publication, Discovery and Excavation in Scotland.

5.5 The gradiometer data were downloaded using Bartington Grad601 PC Software v313 and processed using Geoscan Geoplot v3.0. The details of these processes can be found in Appendices 3 and 4.

5.6 Interpreted point, polyline and polygon layers were created as layers in AutoCAD and technical terminology used to describe identified features can be found in Appendix 5.

6 Results and Interpretation

6.1 Gradiometer survey results have been visualised as greyscale plots with raw data plotted at -1nT to 2nT (Figures 5, 8, 11, 14, 17, 20 & 23) and processed data plotted at -1nT to 2nT (Figures 6, 9, 12, 15, 18, 21 & 24). An interpretation of each area has also been completed and these results are shown in separate illustrations (Figures 7, 10, 13, 16, 19, 22 & 25). An individual characterisation of identified anomalies can be found in Appendix 6.

6.2 The below results discussion has been undertaken by looking at each individual parcel and what anomalies have been located. The conclusion then looks at all the parcels as a whole, drawing upon the overall results and discussing what has been found.

Parcel 1 (Figures 5, 6 & 7)

6.3 A number of discrete linear trends that could be of an archaeological origin have been located within the dataset (**A1**). Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type. It is possible these anomalies belong to structural remains, but poor patterning or response values makes interpretation difficult.

6.4 The majority of other responses seen within the dataset consist of very strong positive anomalies, which would appear to fall within areas which contained large outcrops of rock and boulders (**Plate 1**) (**A2**). It is uncertain if these responses therefore relate to archaeological structures or are infact responses from natural geological deposits. These anomalies contain increased and decreased values especially when compared with background readings over the localised area. Poor patterning or weak signal changes creates difficulty in defining the nature of the anomalies and so interpretation is fairly tentative. On certain geologies, these anomalies could be caused by in-filled natural features or certain rock forms, and it would be necessary to undertake an intrusive archaeological investigation to establish their form and character.

6.5 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A3** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a ‘spike’ representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

Parcel 2 (Figures 5, 6 & 7)

6.6 A number of discrete linear trends that could be of an archaeological origin have been located within the results. Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type. It is possible these anomalies belong to structural remains, but poor patterning or response values makes interpretation difficult. These include a curvilinear trend in the north west of the area which is unusual compared to other responses in the area (**A4**). A group of rectilinear anomalies have also been detected at the south east part of the parcel which again could be anthropogenic in origin (**A5**).

6.7 The majority of responses within the dataset are very strong positive anomalies which would appear to fall within areas which contained rocky outcrops (**A6**). It is uncertain if these responses therefore relate to archaeological structures or responses from natural geological deposits.

6.8 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A7** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a ‘spike’ representing a rapid variation in

the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

Parcel 3 (Figures 8, 9 & 10, and 11, 12 & 13)

6.9 A number of discrete linear trends that could be of an archaeological origin have been located within the dataset. Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type, and several linears are visible in the data at the eastern end of the parcel (**A8**). These could be related to geology or have an archaeological origin. A number of further linear trends that could be related to archaeology are located at the western end of the dataset (**A9**). Furthermore a curvilinear trend is also located at the western extent of the parcel, which although may be geological, could in fact have an archaeological origin (**A10**).

6.10 Additionally, a number of pit-like anomalies have been identified in the data. For the majority of the responses, a natural origin rather than anthropogenic would seem more likely, given the lack of any coherent patterning or associated features (**Plate 2** - **A11**). However, an archaeological origin cannot be ruled out, in particular a tentative link may be drawn with the battlefield located in the area. Burial pits should not be considered unexpected in areas surrounding battlefield sites and these features could be related to the battle or its aftermath.

6.11 A number of areas of geology have been detected in the data. These for the most part correlate with breaks in the slope within the survey area. The first and most noticeable is a central area where the responses are significantly large (**A12**). A second area to the west of these also looks geological in its origin and also correlates with a change in topography (**A13**). A third area of geology is located in the far west of the dataset and is likely to be the result of further geological changes. It is possible that they have an archaeological origin however the results would more likely favour geological variations (**A14**). Areas of disturbance that are composed of irregular significant increases or decreases in values compared with background readings, as in this case, are likely to indicate natural variations in soil composition or geology.

6.12 A linear trend in the central part of the dataset is most likely related to a pipe running through the survey parcel (**A15**). Anomalies of a linear form such as this often consist of contrasting positive and negative values and signify a feature with a high level of magnetisation and are likely to belong to modern activity such as a pipe.

6.13 Two visible above ground boreholes are seen in the data and although attempts were made to avoid these during the survey, they still showed up in the data due to their magnetic form (**A16**). Modern areas of disturbance like this are characterised by significant increases or decreases in values compared with background readings.

6.14 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A17** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a ‘spike’ representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring. However bearing in mind the association of the survey area with a former battlefield, some of these responses could be archaeological in their origin.

Parcel 4 (Figures 11, 12 & 13 and 14, 15 & 16)

6.15 A number of discrete linear trends that could have an archaeological origin have been located within the dataset. Anomalies of a linear form of this type are either composed of an increased or

decreased signal compared to background values. In this case the majority are of a positive increased type, however several negative curvilinear trends are visible in the data (**A18**). These could be related to geology or have an archaeological origin.

6.16 The positive type of anomalies include a group of rectilinear and circular anomalies which have been detected at the south east part of the parcel, which again could have an anthropogenic origin (**A19**). These could be related to a mound like structure visible on the surface that could be archaeological in origin (**Plate 3**). Anomalies like this could belong to structural remains, but poor patterning or response values makes interpretation difficult.

6.17 A further linear trend in the west of the dataset consisting of a positive magnetic anomaly has also been detected (**A20**). Anomalies like this could belong to structural remains, but poor patterning or response values makes interpretation difficult.

6.18 Two visible above ground boreholes are seen in the dataset and although attempts were made to avoid them during the survey, they still showed up in the data due to their magnetic form (**A21**). Modern areas of disturbance like this are characterised by significant increases or decreases in values compared with background readings.

6.19 A number of areas of geology have been detected in the dataset. These for the most part correlate with a break in the slope (**A22 and A23**). A second area to the east of these also looks geological in its origin, although archaeology cannot be ruled out as this area is adjacent to the previously mentioned discrete negative trends (**A19**). Areas of disturbance that are composed of irregular significant increases or decreases in values compared with background readings, as in this case, are likely to indicate natural variations in soil composition or geology.

6.20 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A24** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a 'spike' representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

Parcel 5 (17, 18 & 19)

6.21 A number of discrete linear trends that could be of an archaeological origin have been located within the results. Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type, however one negative rectilinear trend stands out in the dataset particularly (**A25**). This could be related to a trackway as it runs in the general direction of a field entrance. The anomalies relating to positive increased magnetic values by contrast include a group of rectilinear anomalies which have been detected in the north east part of the parcel (**A26**). These could be anthropogenic in their origin. A number of parallel trends are also visible (**A27**). These are most likely to be related to land drains, however they don't follow the normal drainage patterns as usually seen in geophysical results. The anomalies could belong to structural remains, but poor patterning or response values makes interpretation difficult.

6.22 A number of areas of geology have been detected in the data (**A28**). These for the most part run in a north south direction. Areas of disturbance that are composed of irregular significant increases or decreases in values compared with background readings, as in this case, are likely to indicate natural variations in soil composition or geology.

6.23 Two visible above ground boreholes are seen in the data and although attempts were made to avoid these during survey, they still showed up in the data due to their magnetic form (**A29**). Modern areas

of disturbance like this are characterised by significant increases or decreases in values compared with background readings.

6.24 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A30** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a 'spike' representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

Parcel 6 (Figures 20, 21 & 22)

6.25 A number of discrete linear trends that could be of an archaeological origin have been located within the results. Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type, however one negative curvilinear trend is very visible in the data (**A31**). This falls within an area where the topology drops away and the anomaly is likely to be a response to this (**Plate 4**).

6.26 The positive anomalies by contrast include a group of rectilinear anomalies which have been detected at the south east part of the parcel which again could be archaeological in origin (**A32**). A further set are seen in the north east (**A33**). These anomalies would appear to also match visible earthworks on the surface, noted at the time of survey.

6.27 A number of areas of geology have been detected in the data (**A34**). These for the most part run in a north south direction. Areas of disturbance that are composed of irregular significant increases or decreases in values compared with background readings, as in this case, are likely to indicate natural variations in soil composition or geology.

6.28 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A35** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a 'spike' representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

Parcel 7 (Figures 23, 24 & 25)

6.29 A number of linear trends that could be of an archaeological origin have been located within the results. In this case the majority are of a positive increased type and are very visible in the data (**A36** and **A37**). These fall within an area where a number of upstanding earthworks were visible which looked like house platforms. Some of these earthworks may be visible in the dataset (**Plate 5**) (**A36**). Several other anomalies correlate with earthworks visibly running across the area (**A37**).

6.30 A number of discrete linear trends that could be of an archaeological origin have been located within the results. Anomalies of a linear form of this type are either composed of an increased or decreased signal compared to background values. In this case the majority are of a positive increased type, and may well relate to the linears correlating to the housing platforms (**A38**).

6.31 A trackway is visible in the data and it would appear to be still in use today. This is possibly constructed of modern material used to build the track up and keep it firm, and this material would appear to be magnetic in contrast to the surrounding survey area (**A39**). Modern areas of disturbance like this are characterised by significant increases or decreases in values compared with background readings.

6.32 A number of areas of clear geology have been detected in the data (**A40**). These for the most part run in a north south direction. Areas of disturbance that are composed of irregular significant

increases or decreases in values compared with background readings, as in this case, are likely to indicate natural variations in soil composition or geology. A number of these also relate to changes in topography across the area.

6.33 A number of isolated dipolar anomalies (iron spikes) have been located throughout the area in no regular pattern (**A41** as an example). Responses of this type are normally caused by ferrous materials on the surface or within the topsoil of the site, which cause a 'spike' representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and usually represent modern material often re-deposited during manuring.

7 Conclusion

7.1 The gradiometer survey has identified a number of possible anomalies and features of archaeological interest in Parcel 7. These would appear to correlate with the earthworks that resembled house platforms that were visible in the survey area.

7.2 Both negative and positive discrete linear and curvilinear trends have been detected in all of the survey parcels. These results might all have an archaeological origin however due to the size and shape of these anomalies and the corresponding background geology, the results could have a more natural origin.

7.3 Only further intrusive evaluation of these identified discrete linear and curvilinear trends would ascertain if they are archaeological in origin.

7.4 A number of pit-like anomalies were detected in Parcel 3 which could be archaeological in origin, but again they could possibly relate to natural geological variations. The identified anomalies could correlate with the associated battlefield site, for example the pits could represent remains such as burial pits. However this theory is only tentative and further intrusive excavation is required.

7.5 A pipe anomaly was detected in Parcel 3, and several areas of magnetic disturbance particularly around the field boundaries has been detected throughout all the parcels.

7.6 Ferrous spikes have also been located throughout and all these responses would suggest modern activity across the parcels.

8 Statement of Indemnity

8.1 Although the results and interpretation detailed in this report have been produced as accurately as possible, it should be noted that the conclusions offered are a subjective assessment of collected data sets.

8.2 The success of a geophysical survey in identifying archaeological remains can be heavily influenced by several factors, including geology, seasonality, field conditions, the technique used and the properties of archaeological features being detected. Therefore geophysical survey may only reveal certain archaeological features and not create a complete plan of all the archaeological remains within a survey area.

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Plate 1. Parcel 1 showing survey area and boulders

Plate 2. Parcel 3 showing area at the eastern end where possible pit locations are found

Plate 3. Parcel 4 showing mound areas and rocky outcrops

Plate 4. Parcel 6 showing earthworks

Plate 5. Parcel 7 showing possible house platforms

Appendix 1: Survey Information

Field	Description
Surveyor	AOC Archaeology
Client	Jacobs UK Ltd (Jacobs)
Site	A9 Dualling Programme Pass of Birnam to Glen Garry: Archaeological Geophysical Survey
County	Perth and Kinross
NGR	NN 89629 64150
Solid geology	Bedrock geology: predominantly Killiecrankie Schist Formation-Semipelite and Micaceous Psammite, with Blair Atholl Dark Limestone and Dark Schist Formation-Metalimestone, Gaick Psammite Formation-Psammite, Tummel Psammite Formation-Psammite and Flaggy Semipelite and Tummel Quartzite Formation-Quartzite. Superficial geology: Alluvium, Devensian Till-Diamicton and Hummocky (moundy) Glacial Deposits-Diamicton,Sand and Gravel [unlithified] (BGS 2016).
Soil composition	Humus-iron podzols and Brown earths (Scotland's Soils 2016).
Historical documentation/ mapping on site	None
Known archaeology on site	See archaeological background
Scheduled Ancient Monument	No
Land use/ field condition	Pasture / fallow / overgrown
Duration	14/11/16-18/11/16
Weather	Sunny, with snowy intervals
Survey type	Gradiometer Survey
Instrumentation	Trimble GXOR system Bartington Grad 601-2
Area covered	Approx 10 ha (163 full or partial grids)
Data collection staffing	James Lawton, Kimberley Teale, Alistair Galt
Download software	Grad601 PC Software v313
Processing software	Geoplot v3.0
Visualisation software	AutoCAD LT 2009
Report title	A9 Dualling Programme, Pass of Birnam to Glen Garry, Scotland: Archaeological Geophysical Survey
Project number	51640
Report Author	James Lawton
Report approved by	Graeme Cavers

Appendix 2: Archaeological Prospection Techniques, Instrumentation and Software Utilised

Gradiometer survey

Gradiometer surveys measure small changes in the earth's magnetic field. Archaeological materials and activity can be detected by identifying changes to the magnetic values caused by the presence of weakly magnetised iron oxides in the soil (Aspinall *et al.*, 2008, 23; Sharma, 1997, 105). Human inhabitation often causes alterations to the magnetic properties of the ground (Aspinall et al, 2008, 21). There are two physical transformations that produce a significant contrast between the magnetic properties of archaeological features and the surrounding soil: the enhancement of magnetic susceptibility and thermoremnant magnetization (Aspinall *et al.*, 2008, 21; Heron and Gaffney 1987, 72).

Ditches and pits can be easily detected through gradiometer survey as the top soil is generally suggested to have a greater magnetisation than the subsoil caused by human habitation. Also areas of burning or materials which have been subjected to heat commonly have high magnetic signatures, examples include: hearths, kilns, fired clay and mudbricks (Clark 1996, 65; Lowe and Fogel 2010, 24). It should be noted that negative anomalies can also be useful for characterising archaeological features. If the buried remains are composed of a material with a lower magnetisation compared with the surrounding soil, the surrounding soil will consequently have a greater magnetisation resulting in the feature displaying a negative signature. For example stone materials of a structural nature that are composed of sedimentary rocks are considered non-magnetic and so will appear as negative features within the data set.

Ferrous objects- i.e. iron and its alloys- are strongly magnetic and are typically detected as high-value peaks in gradiometer survey data, though it is not usually possible to determine whether these relate to archaeological or modern objects.

Although gradiometer surveys have been successfully carried out in all areas of the United Kingdom, the effectiveness of the technique is lessened in areas with complex geology, particularly where igneous and metamorphic bedrock is present. All magnetic geophysical surveys must therefore take the effects of background geological and geomorphological conditions into account.

Gradiometer survey instrumentation

AOC Archaeology's gradiometer surveys are carried out using Bartington Grad601-2 magnetic gradiometers. The Grad601-2 is a high-stability fluxgate magnetic gradient sensor, which uses a 1m sensor separation. The detection resolution is from 0.03 nT/m to 0.1nT/m, depending on the sensor parameters selected, making the Grad601-2 an ideal instrument for prospective survey of large areas as well as detailed surveys of known archaeology. The instrument stores the data collected on an on-board data-logger, which is then downloaded as a series of survey grids for processing.

Gradiometer survey software

Following the survey, gradiometer data was downloaded from the instrument using Grad601 PC Software v313. Survey grids were then assembled into composites and enhanced using a range of processing techniques which are applied to the data using Geoscan's Geoplot v3.0 (see Appendix 3 for a summary of the processes used in Geoplot and Appendix 4 for a list of processes used to create final data plots).

Appendix 3: Summary of Processes used in Geoplot

Process	Effect
Clip	Replaces data values outside a specified range, in order to display important data with relative values stretched across the display range.
De-spike	Removes exceptionally high values represented in the data that can obscure the visibility of archaeological features. In resistivity survey, these can be caused by poor contact of the mobile probes with the ground; in gradiometer survey, these can be caused by highly magnetic items such as buried ferrous objects.
De-stagger	Counteracts the striping effect caused by misalignment of data when collected on a zig-zag traverse pattern.
Edge Match	Counteracts edge effects in grid composites by subtracting the difference between mean values in the two lines either side of the grid edge.
High pass filter	Removes low-frequency, large scale detail in order to remove background trends in the data, such as variations in geology.
Interpolate	Increases the resolution of a survey by interpolating new values between surveyed data points
Low Pass filter	Uses a Gaussian filter to remove high-frequency, small scale detail, typically for smoothing or generalising data.
Periodic Filter	Used to either remove or reduce amplitudes of constant and reoccurring features that distort other potential patterns. An example of which is plough lines.
Wallis filter	Applies a locally adaptive contrast enhancement filter.
Zero Mean Grid	Resets the mean value of each grid to zero, in order to counteract edge discontinuities in composite assemblies.
Zero Mean Traverse	Resets the mean value of each traverse to zero, in order to address the effect of striping in the data and counteract edge effects.

Appendix 4: Survey Processing Steps

Process	Extent
Survey Area	
Zero Mean Traverse	All LMS =on, threshold -5 to 5
Despike	X=1 Y=1 Thr = 3 Repl = Mean
Clip	Min =-5 Max = 5
Destagger	All grids dir Shift = 2 Line Pattern 34-78 Dual-DS
Low Pass filter	X=1 Y=1 Wt=G
Interpolate	Y, Expand – Expand –SinX/X x2
Raw Palette Scale	Grey55 Min= - Max= 2
Palette Scale	Grey55 Min= -1 Max= 2

Appendix 5: Technical Terminology

Type of Anomaly	Description
Archaeology (Isolated Linear trends)	
Linear trend (field boundary)	Isolated long linear anomalies that are likely to relate to field boundaries. Signal may appear inconsistent but patterning and positioning, especially when compared with historic mapping suggests such anomalies belong to former field division systems
Linear trend (field boundary?)	Anomalies of a long linear form, but lack the necessary patterning, signal strength or positioning to be positively identified as field boundaries.
Archaeology	
Linear trend (fortification)	Linear anomalies that are composed of a patterning and positioning that is likely to relate to structural remains such as town fortifications. These anomalies can be composed of either an increase or decrease in magnetic values, relating to in-filled ditches or buried walls.
Linear trend (road)	A regular linear trend that is identified through the absence of buried remains, especially through areas containing a variety of rectilinear anomalies that appear to have structural associations.
Linear trend (archaeology)	These can either be isolated linear anomalies or rectilinear in form and often suggest the presence of structural remains. Anomalies are either characterised by an increase or decrease in signal compared to background values depending on the properties of the feature being recorded.
Disturbed area (archaeology)	These are characterised by a general increase or decrease in the magnetic background over a localised area but do not appear as having a linear form. These anomalies do not have the high dipolar response which are manifested in an 'iron spike' anomaly, and can be the result of in-filled pits and post-holes, or kilns.
Pit	Isolated circular anomalies composed of an increase in magnetic values with a patterning that is suggestive of buried remains such as the infill of a pit
Discrete	
Linear trend (archaeology?)	Anomalies of a linear form either composed of an increased or decreased signal compared to background values. It is possible these anomalies belong to structural remains, but poor patterning or response values makes interpretation difficult.
Disturbed area (archaeological?)	Anomalies with an increase or decrease in values compared with background reading over a localised area. Poor patterning or weak signal changes creates difficulty in defining the nature of the archaeology and so interpretation is fairly tentative. On certain geologies these anomalies could be caused by in-filled natural features, and it would be necessary to undertake intrusive archaeological investigation to establish their form and character.
Possible archaeology (Unclear as to origins of the remains)	Anomalies composed of a weak change in signal values compared to background reading or are composed of incomplete patterning. Consequently, interpretation is tentative and it is unclear to whether anomalies are archaeological in their nature.

(Archaeology?) (Unclear as to origins of the remains)	As with above, but located in an area previously excavated so is either potentially a product of excavation-related activity or relates to subtle changes in the magnetic properties in the soil caused by earlier activity, which was not detected during previous archaeological assessment works.
Area of Disturbance (archaeology?)	A large area of general disturbance which could relate to earlier human activity which has caused an increase in the magnetic properties of the soil. Generally these areas contain a variety of increased and decreased magnetic values, but lack sufficient patterning for detailed interpretation. They could indicate the presence of buried rubble relating to fallen structures, or instead denote modern material either caused by quarrying or agricultural activity.
Pit?	Isolated circular anomalies composed of an increase in magnetic values with a patterning that may be suggestive of buried remains such as the infill of a pit.
Linear trend (plough lines)	A series of regular anomalies of a linear form either composed of an increased or decreased signal compared to background values. Likely to denote the presence of ploughing and relating to archaeological agricultural activity such as ridge and furrow ('Rig and Furrow' in Scotland).
Non- Archaeology	
Linear trend (plough lines)	A series of regular anomalies of a linear form either composed of an increased or decreased signal compared to background values. Likely to denote the presence of ploughing and relating to modern agricultural activity.
Linear trend (agricultural)	Series of linear anomalies, of an indeterminate date, likely to have been caused by agricultural activity such as ploughing and land drainage
Linear trend (modern?)	Anomalies of a linear form that are likely to belong to modern features, but are composed of values, patterning or positioning which makes definite interpretation difficult
Disturbed area (modern?)	Area of disturbance that is composed of significant increases or decreases in values compared with background readings. It is highly likely that these readings are caused by modern disturbances, but interpretation is tentative.
Linear trend (modern)	Anomalies of a linear form often composed of contrasting positive and negative values. Such anomalies usually signify a feature with a high level of magnetisation and are likely to belong to modern activity such as pipe lines
Disturbed area (modern)	Area of disturbance that is likely to be caused by modern disturbances and is characterised by significant increases or decreases in values compared with background readings.
Isolated dipolar anomalies (iron spikes)	Response normally caused by ferrous materials on the surface or within the top soil of the site, which cause a 'spike' representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and generally represent modern material often re-deposited during manuring.
Geology	Area of disturbance that is composed of irregular significant increase or decreases in values compared with background readings and are likely to indicate natural variations in soil composition or geology

Appendix 6: Individual Characterisation of Identified Anomalies

(Site Name: A9 Dualling Programme, Pass of Birnam to Glen Garry)

Anomaly Identifier	Type of Archaeology
A1	Discrete linear trend (Positive)
A2	Strong positive anomalies, Geology?
A3	Isolated Ferrous Spikes
A4	Discrete linear trend (Positive)
A5	Discrete linear trend (Positive)
A6	Strong positive anomalies, Geology?
A7	Isolated Ferrous Spikes
A8	Discrete linear trend, Archaeology?
A9	Discrete linear trend (Negative)
A10	Curvilinear trend, Geology?
A11	Pits, Geology?
A12	Breaks in slope, Geology
A13	Topography, Geology
A14	Geology
A15	Service Pipe
A16	Boreholes
A17	Dipolar anomalies
A18	Curvilinear trend (Negative), Archaeology?
A19	Rectilinear and Circular anomalies, Archaeology?
A20	Linear trend, Archaeology?
A21	Boreholes
A22	Break in slope, Geology
A23	Geology?
A24	Dipolar anomalies
A25	Discrete rectilinear trend (Negative), Archaeology?
A26	Rectilinear anomalies (Positive), Archaeology
A27	Parallel trends, Archaeology?
A28	Geology
A29	Boreholes
A30	Dipolar anomalies
A31	Curvilinear trend (Negative), Geology
A32	Rectilinear anomalies (Positive), Archaeology?
A33	Rectilinear anomalies (Positive), Archaeology?
A34	Geology
A35	Dipolar anomalies
A36	Linear trend (Positive), Archaeology
A37	Linear trend (Positive), Archaeology
A38	Discrete Linear Trend
A39	Trackway
A40	Geology
A41	Dipolar anomalies

Appendix 7: Photograph Register and Condition Survey

Photo Register	
Site Name	A9 Dualling Programme, Pass of Birnam to Glen Garry
Project number	51640

Reference number	Date taken	Photo Name	Survey area reference number	Weather conditions	Direction of photo	Comment
A1	15/11/2016	20161115_093305	Parcel 1	Overcast	SW	Survey area - before survey
A2	15/11/2016	20161115_093308	Parcel 1	Overcast	E	Survey area -after survey
A3	15/11/2016	20161115_094456	Parcel 2	Overcast	E	Survey area - before survey
A4	15/11/2016	20161115_094459	Parcel 2	Overcast	E	Survey area - after survey
A5	15/11/2016	20161115_094502	Parcel 2	Overcast	N	Survey area - access
A6	15/11/2016	20161115_101031	Parcel 2	Overcast	N	Survey area - unsurveyable
A7	17/11/2016	20161117_122817	Parcel 3	Sunny & overcast	SW	Survey area - before survey
A8	17/11/2016	20161117_122819	Parcel 3	Sunny & overcast	S	Survey area - after survey
A9	17/11/2016	20161117_123322	Parcel 3	Sunny & overcast	SE	Survey area - before survey
A10	17/11/2016	20161117_123324	Parcel 3	Sunny & overcast	SE	Survey area - after survey
A11	16/11/2016	20161116_123758	Parcel 4	Sunny	E	Survey area- before survey
A12	16/11/2016	20161116_123801	Parcel 4	Sunny	SE	Survey area - after survey
A13	16/11/2016	20161116_124753	Parcel 4	Sunny	W	Survey area-unsurveyable
A14	15/11/2016	20161115_143749	Parcel 5	Sunny	N	Survey area - before survey
A15	15/11/2016	20161115_143800	Parcel 5	Sunny	S	Survey area - after survey
A16	16/11/2016	20161116_093322	Parcel 6	Overcast, snow	E	Survey area - unsurveyable
A17	16/11/2016	20161116_093324	Parcel 6	Overcast, snow	E	Survey area - before survey
A18	16/11/2016	20161116_093412	Parcel 6	Overcast, snow	E	Survey area - after survey
A19	16/11/2016	20161116_093352	Parcel 6	Overcast, snow	E	Survey area - unsurveyable
A20	16/11/2016	20161116_095233	Parcel 7	Overcast	N	Survey area - access
A21	16/11/2016	20161116_095237	Parcel 7	Overcast	S	Survey area - before survey
A22	16/11/2016	20161116_095943	Parcel 7	Overcast	SE	Survey area - after survey
A23	16/11/2016	20161116_101148	Parcel 7	Sunny	SE	Survey area - before survey
A24	16/11/2016	20161116_101151	Parcel 7	Sunny	SE	Survey area - after survey
A25	16/11/2016	20161116_095947	Parcel 7	Rain	S	Survey area - before survey
A26	16/11/2016	20161116_095949	Parcel 7	Rain	S	Survey area - after survey
A27	16/11/2016	20161116_102828	Parcel 7	Rain	SE	Survey area - unsurveyable
A28	16/11/2016	20161116_104000	Parcel 7	Rain	SW	Survey area - before survey
A29	16/11/2016	20161116_104001	Parcel 7	Rain	SW	Survey area - after survey

Appendix 8: Discovery and Excavation in Scotland text

Appended to OASIS entry:

As part of the A9 dualling programme, magnetometry survey of seven parcels, totalling approximately 10 Ha, was carried out between the Pass of Birnam and Glen Garry. The results produced evidence for settlement in the northern sections of the survey area (close to Aldclune), as well as a series of pit-like anomalies close to the site of the Battle of Killiecrankie. Several other isolated linear and pit-like features were identified across the survey area, tentatively identified as archaeological in origin.

Sponsor: Jacobs UK

Contributors: James Lawton, Kimberley Teale, Alistair Galt

Condition Survey Photographs

Photo A1 – Parcel 1 before survey

Photo A2 – Parcel 1 after survey

Photo A3 – Parcel 2 before survey

Photo A4 – Parcel 2 after survey

Photo A5 – Access to Parcel 2

Photo A6 – Parcel 2 (unsurveyable)

Photo A7 – Parcel 3 before survey

Photo A8 – Parcel 3 after survey

Photo A9 – Parcel 3 before survey

Photo A10 – Parcel 3 after survey

Photo A11 – Parcel 4 before survey

Photo A12 – Parcel 4 after survey

Photo A13 – Parcel 4 (unsurveyable)

Photo A14 – Parcel 5 before survey

Photo A15 – Parcel 5 after survey

Photo A16 – Parcel 6 (unsurveyable)

Photo A17 – Parcel 6 before survey

Photo A18 – Parcel 6 after survey

Photo A19 – Parcel 6 after survey

Photo A20 – Parcel 7 access

Photo A21 – Parcel 7 before survey

Photo A22 – Parcel 7 after survey

Photo A23 – Parcel 7 before survey

Photo A24 – Parcel 7 after survey

Photo A25 – Parcel 7 before survey

Photo A26 – Parcel 7 after survey

Photo A27 – Parcel 7 (unsurveyable)

Photo A28– Parcel 7 after survey

Photo A29 – Parcel 7 after survey

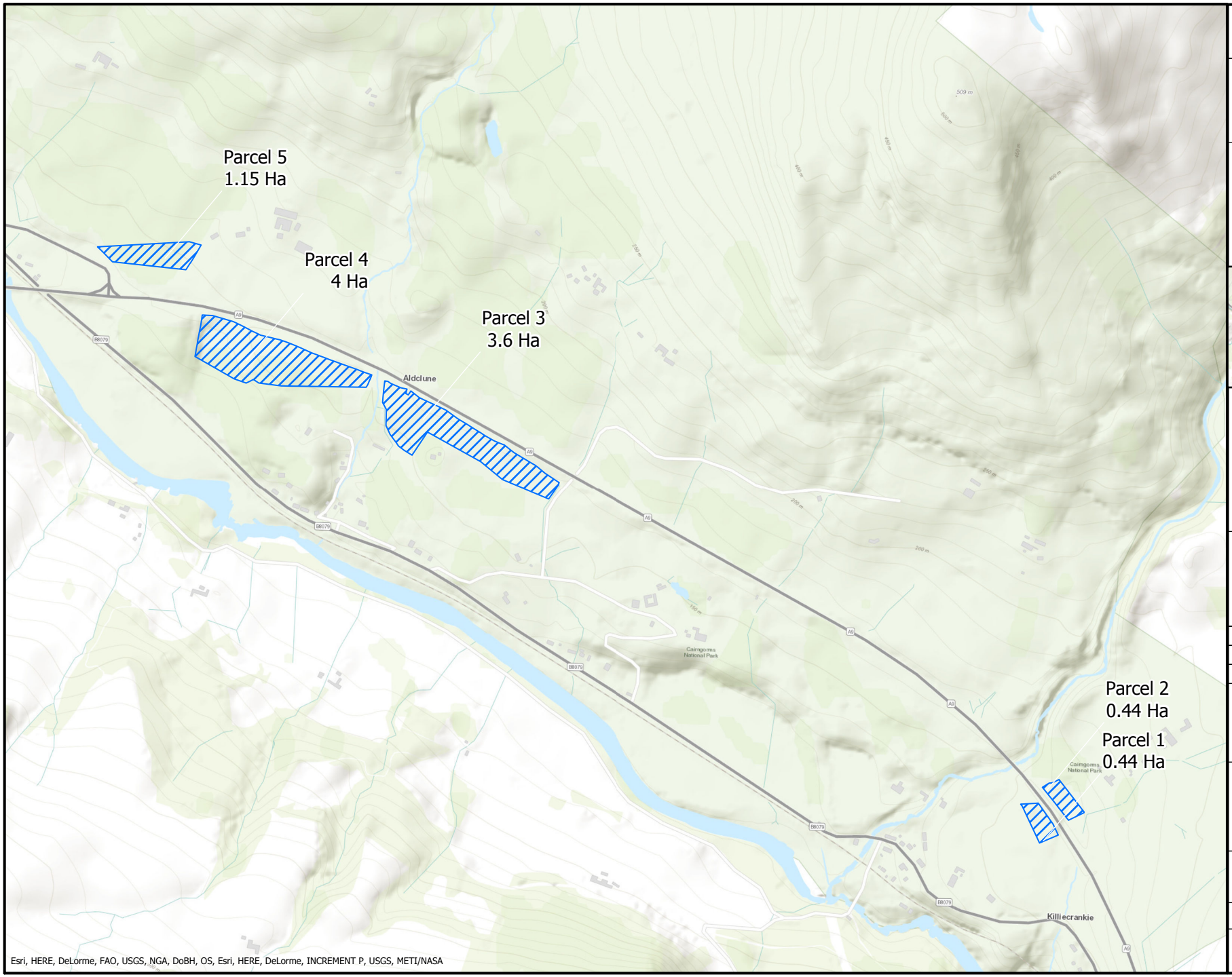
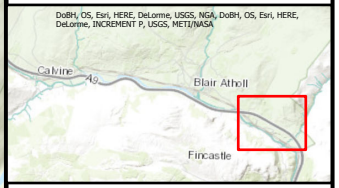


Figure	1A

A9 Dualling: Geophysical Survey
Survey areas

Legend

Geophysical Survey Parcels



TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

A9 DUALLING
PERTH TO INVERNESS

FOR

JACOBS

Drawn/checked:	GC/GH
DWG no:	02/51640/Rep/1A/01
AOC Project No.:	51640

AOC Archaeology Group

N

SYSTEM
Name: British National Grid
PCS: British National Grid
GCS: GCS OSGB 1936
Datum: OSGB 1936
Projection: Transverse Mercator

SCALE
1:12,500 @ A3

SCALE
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Kilometers

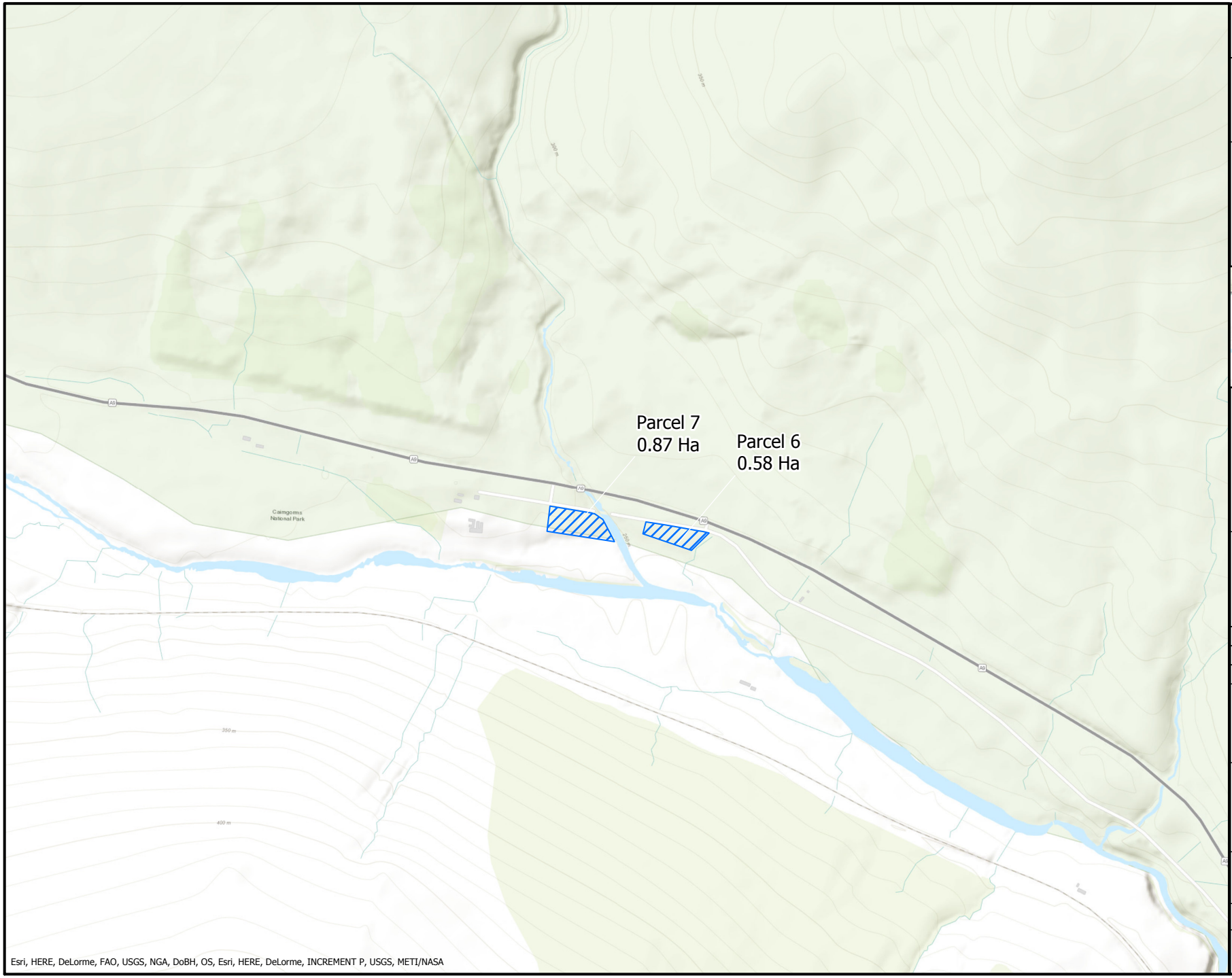
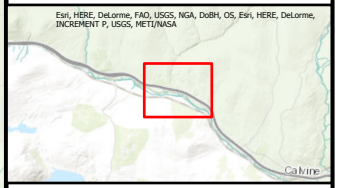


Figure	1B

A9 Dualling: Geophysical Survey
Survey areas

Legend

Geophysical Survey Parcels



TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

A9 DUALLING
PERTH TO INVERNESS

FOR

JACOBS

Drawn/checked:	GC/GH
DWG no:	02/51640/Rep/1B/01
AOC Project No.:	51640

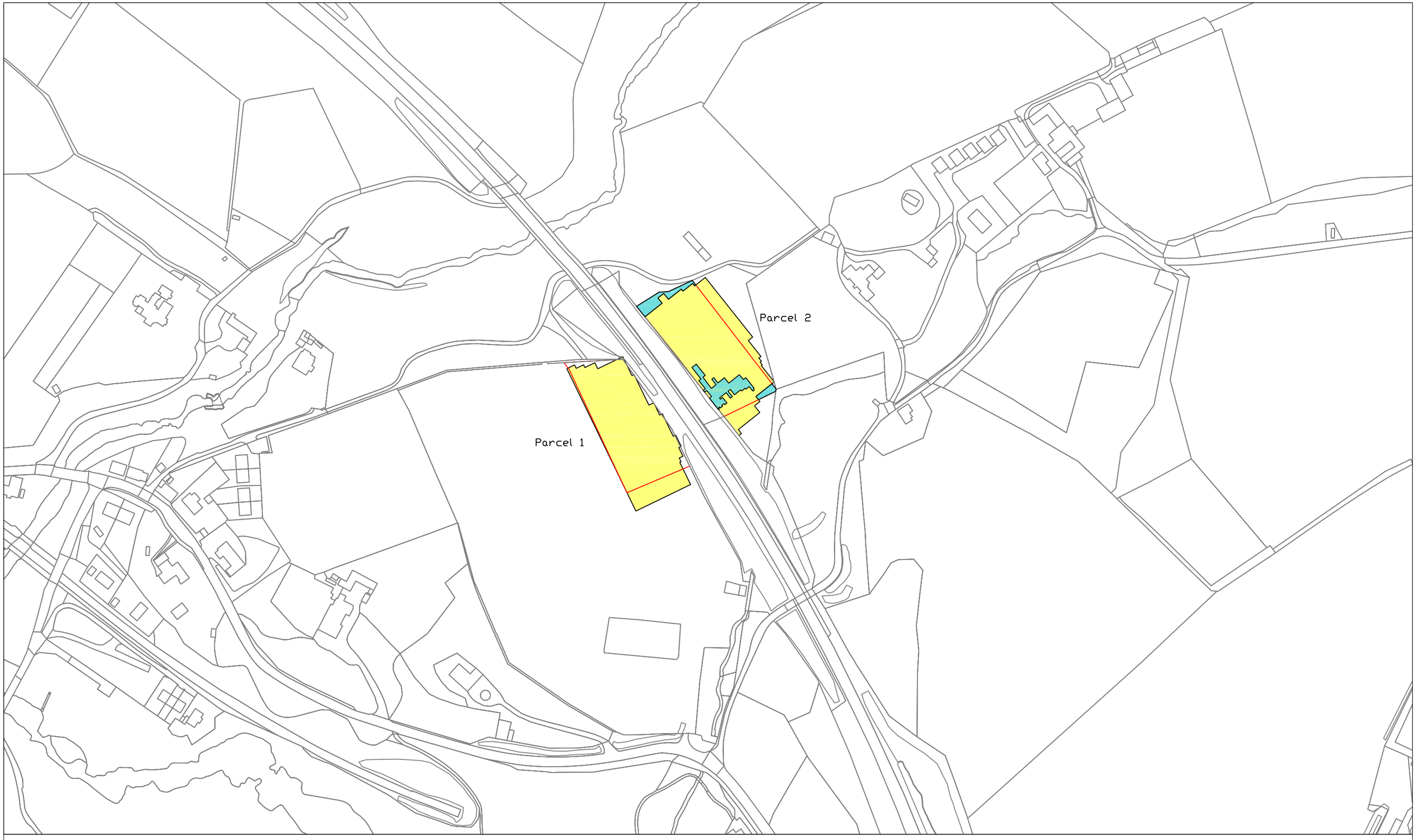
AOC Archaeology Group

N

SYSTEM
Name: British National Grid
PCS: British National Grid
GCS: GCS OSGB 1936
Datum: OSGB 1936
Projection: Transverse Mercator

SCALE
1:12,500 @ A3

SCALE
0 0.1 0.2 0.3 0.4
Kilometers



Location of Survey Areas - Parcel 1 and Parcel 2

Figure 2

N

Surveyed area
Unsurveyable area
Survey Boundary

0 100m
1:2500 at A3

AOC Archaeology Group

Location of Survey Areas - Parcel 3, Parcel 4 and Parcel 5

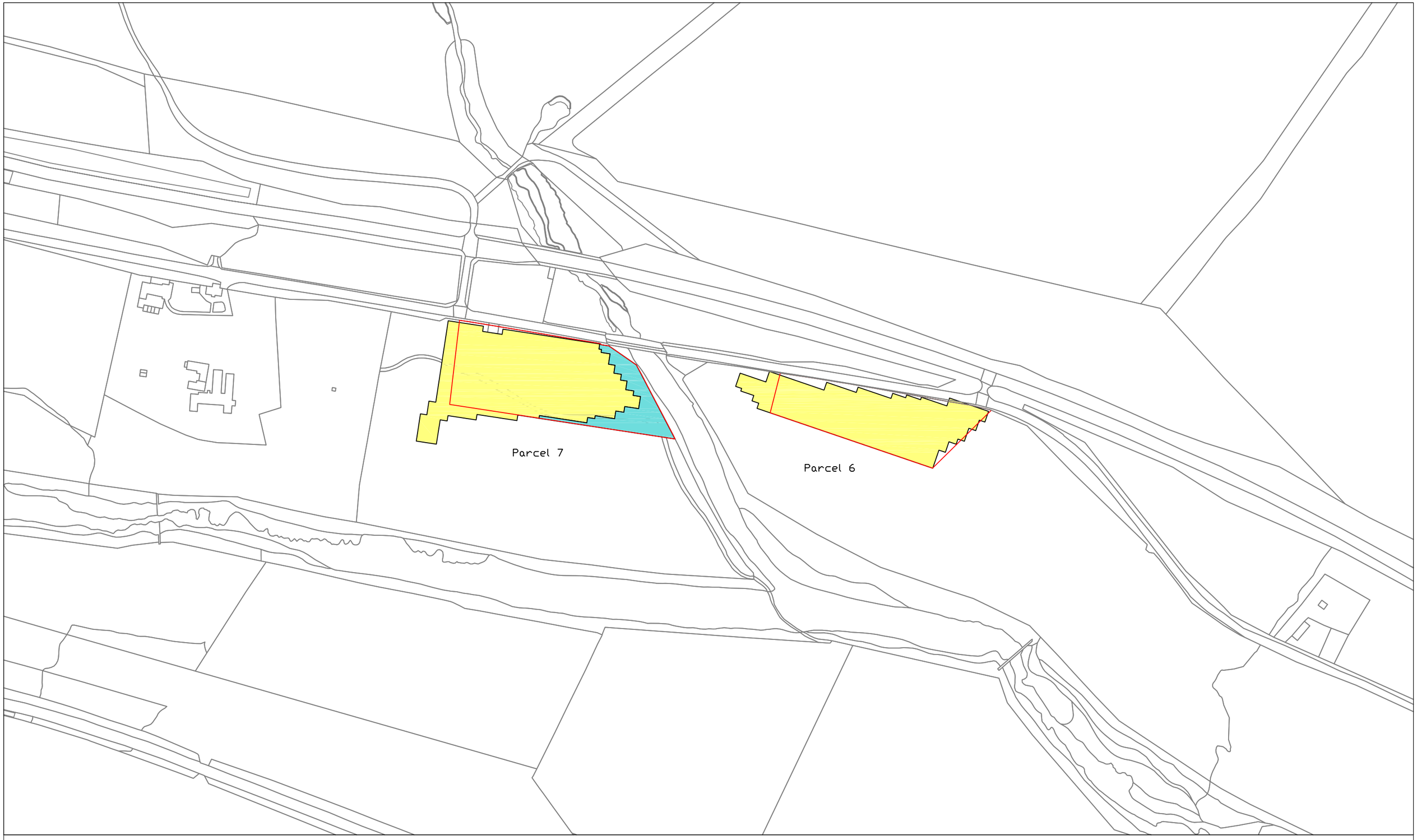
Figure 3

N

Surveyed area
Unsurveyable area
Survey Boundary

0 120m
1:3000 at A3

AOC Archaeology Group



Location of Survey Areas - Parcel 6 and Parcel 7

Figure 4

N

Surveyed area
Unsurveyable area
Survey Boundary

0 100m
1:2500 at A3

AOC Archaeology Group

Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 1 and Parcel 2

Figure 5

N

0 40m

1:1000 at A3

AOC Archaeology Group

Processed Gradiometer Survey Results - Greyscale Plots - Parcel 1 and Parcel 2

Figure 6

N

0 40m

1:1000 at A3

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Interpretation Plots - Parcel 1 and Parcel 2

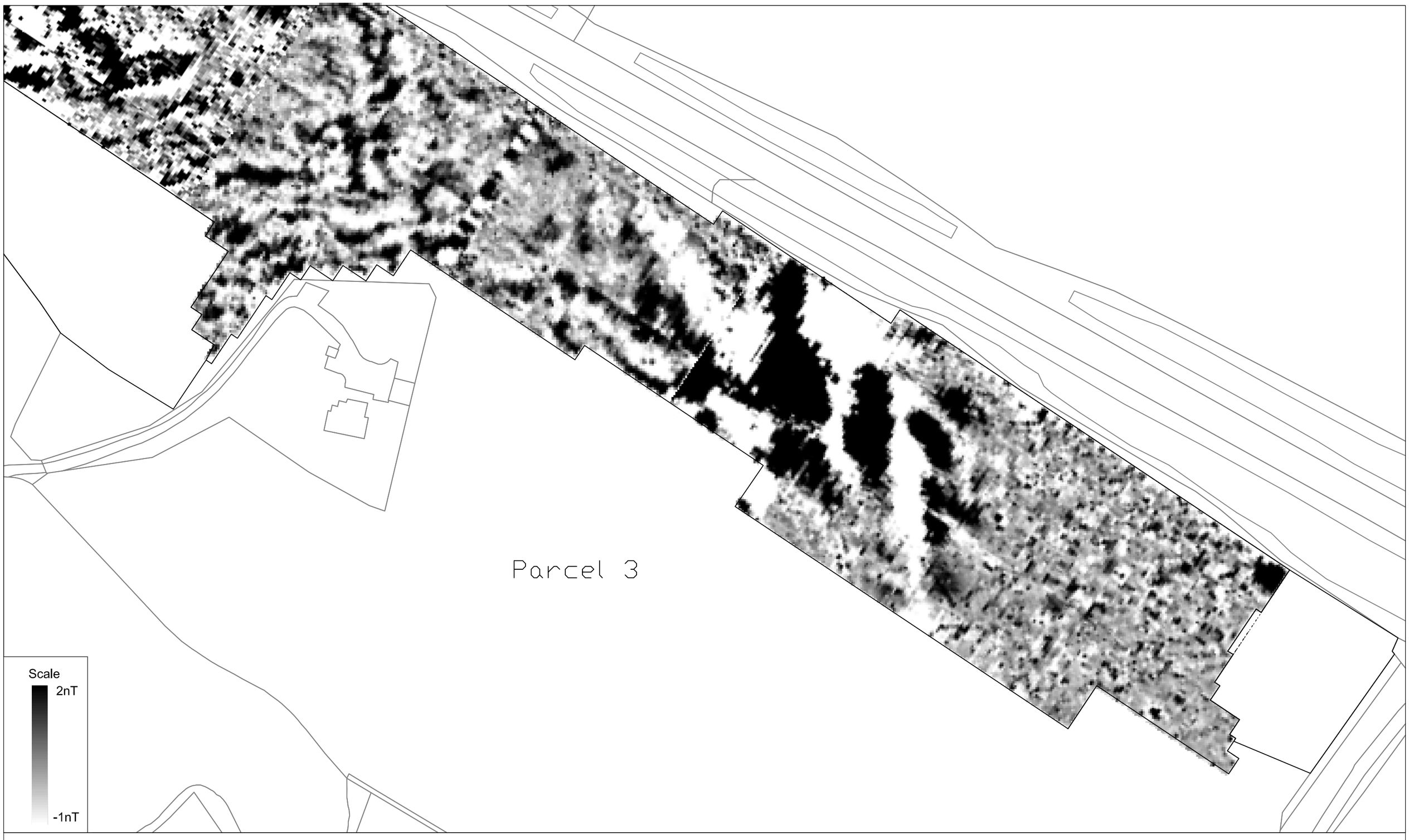
Figure 7

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Iron Spikes / Ferrous

0 40m
1:1000 at A3

AOC Archaeology Group



Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 3 - Eastern extent

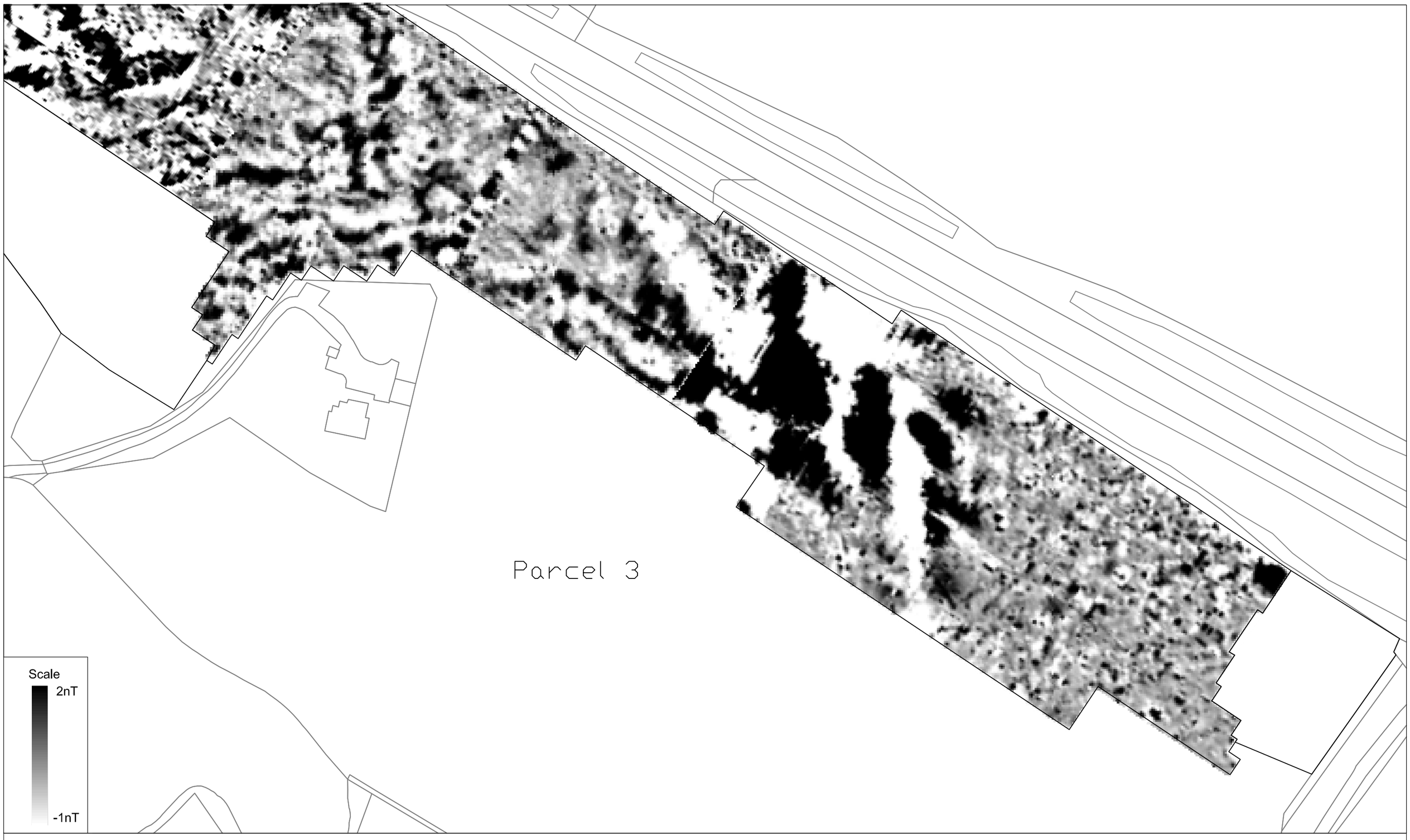
Figure 8

N

0 40m

1:1000 at A3

AOC Archaeology Group



Processed Gradiometer Survey Results - Greyscale Plots - Parcel 3 - Eastern extent

Figure 9

N

0 40m

1:1000 at A3

AOC Archaeology Group

Interpretation Plots - Parcel 3 - Eastern extent

Figure 10

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Pit
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

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Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 3 - Western extent, and Parcel 4 - Eastern extent

Figure 11

N

0 40m

1:1000 at A3

AOC Archaeology Group

Processed Gradiometer Survey Results - Greyscale Plots - Parcel 3 - Western extent, and Parcel 4 - Eastern extent

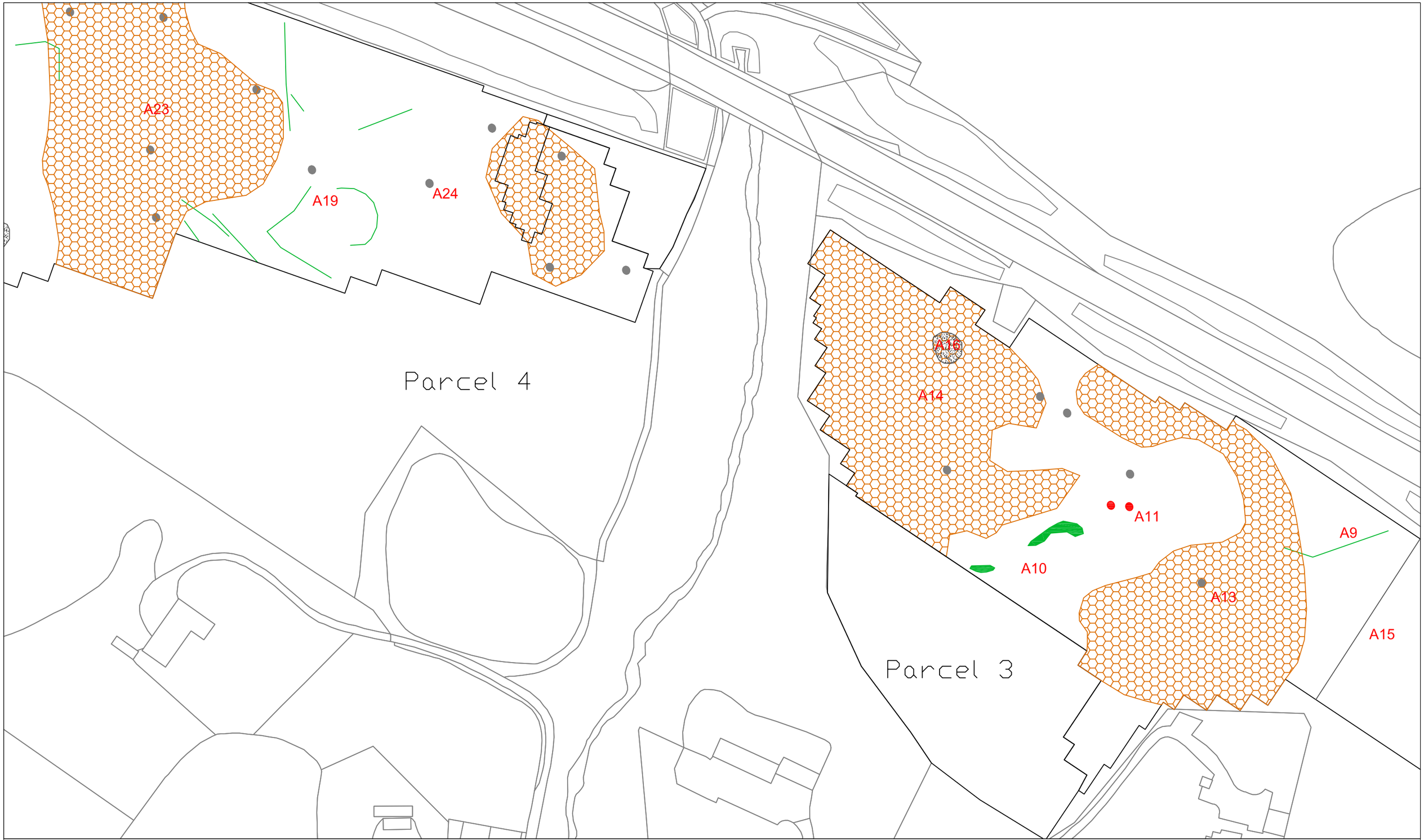
Figure 12

N

0 40m

1:1000 at A3

AOC Archaeology Group



Interpretation Plots - Parcel 3 - Western extent, and Parcel 4 - Eastern extent

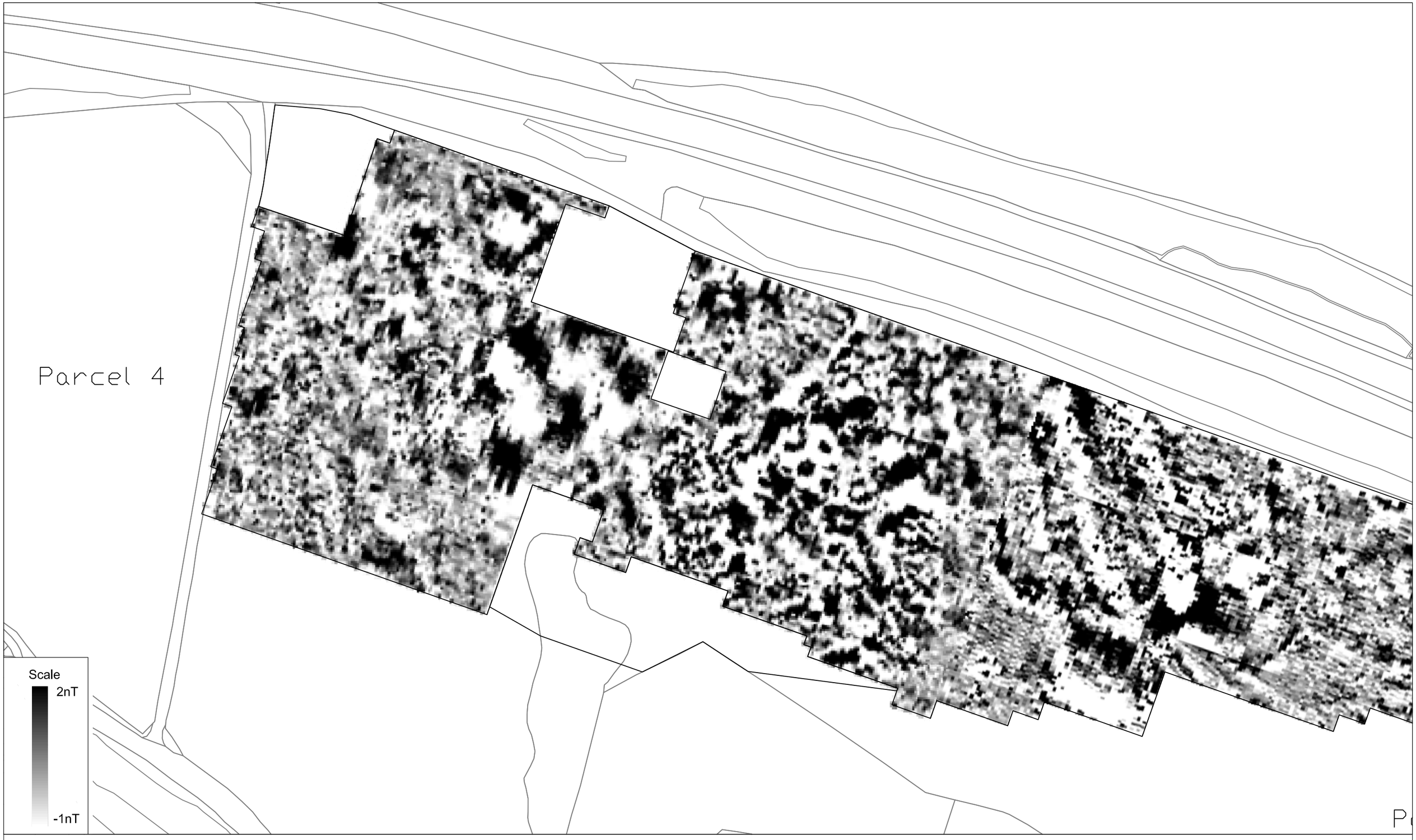
Figure 13

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Pit
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

AOC Archaeology Group



Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 4 - Western extent

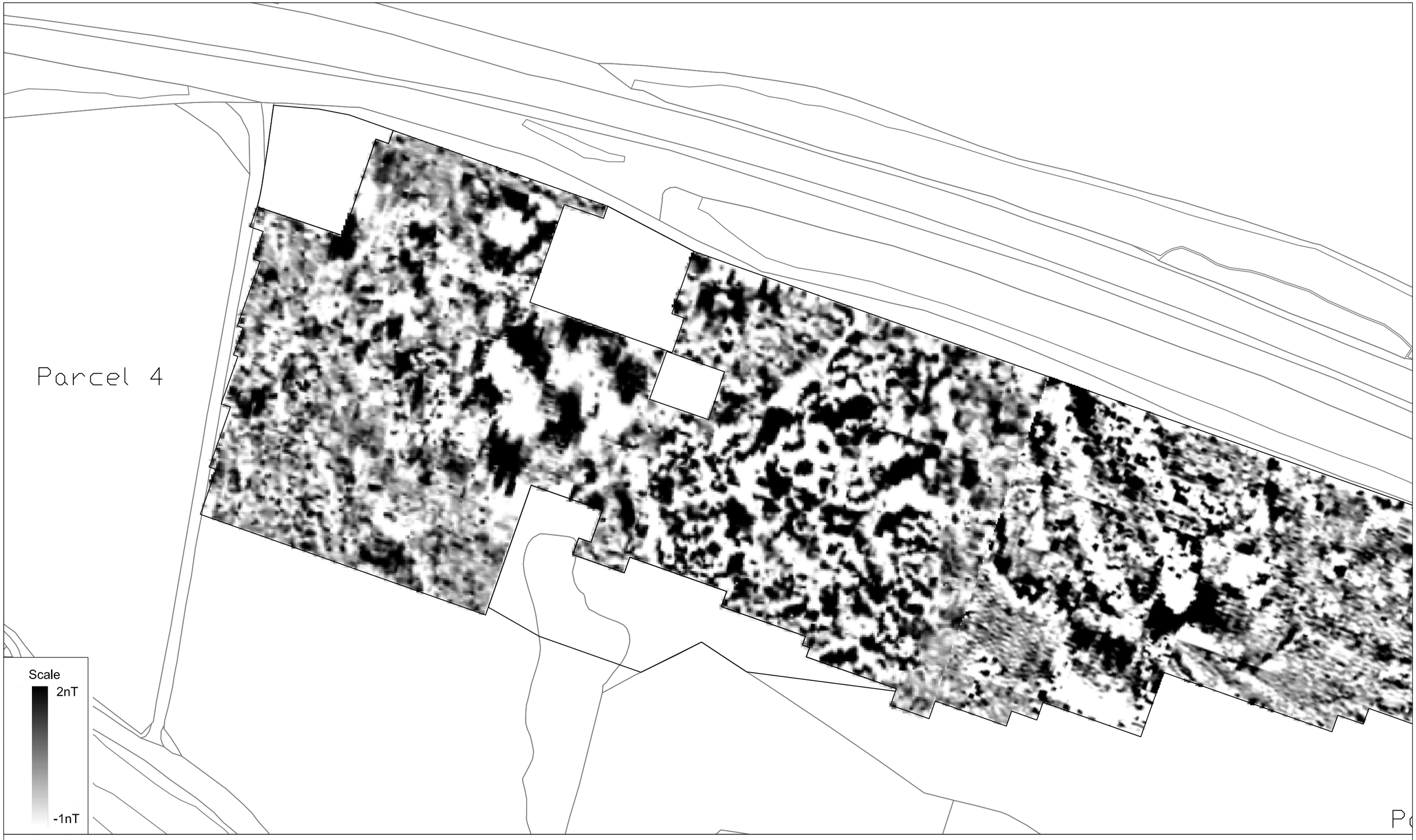
Figure 14

N

0 40m

1:1000 at A3

AOC Archaeology Group



Processed Gradiometer Survey Results - Greyscale Plots - Parcel 4 - Western extent

Figure 15

N

0 40m

1:1000 at A3

AOC Archaeology Group

Interpretation Plots - Parcel 3 - Western extent, and Parcel 4 - Eastern extent

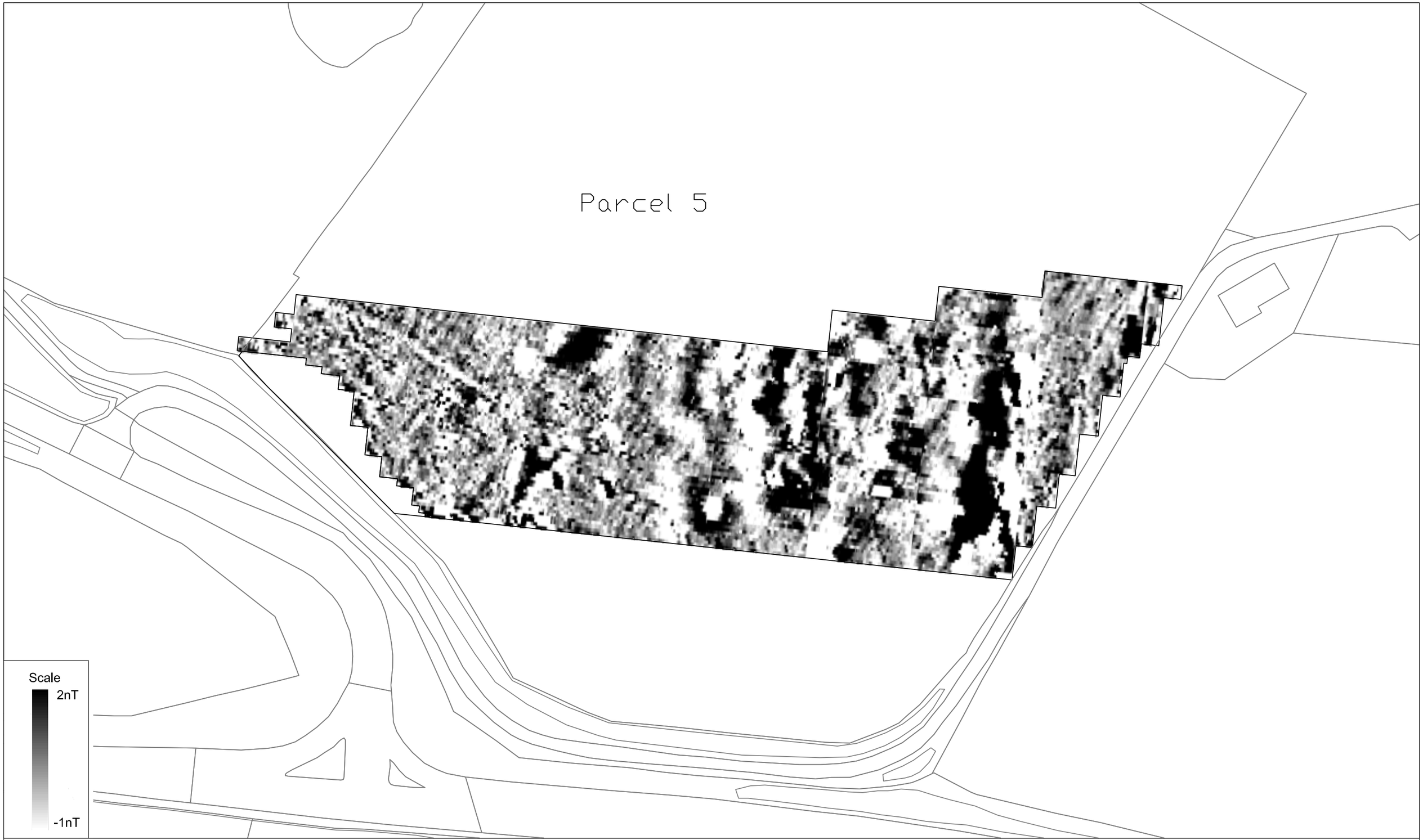
Figure 16

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

AOC Archaeology Group



Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 5

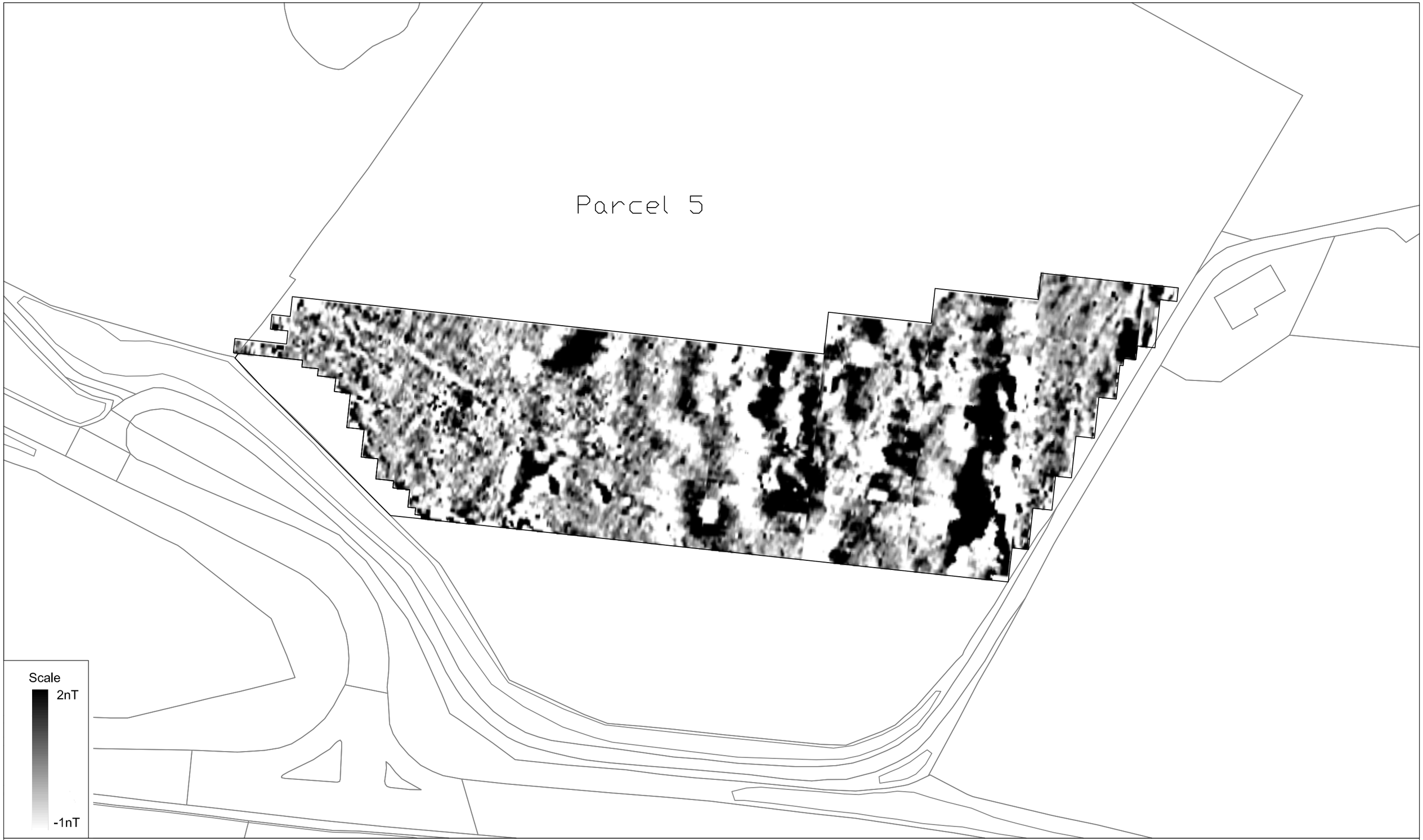
Figure 17

N

0 40m

1:1000 at A3

AOC Archaeology Group



Processed Gradiometer Survey Results - Greyscale Plots - Parcel 5

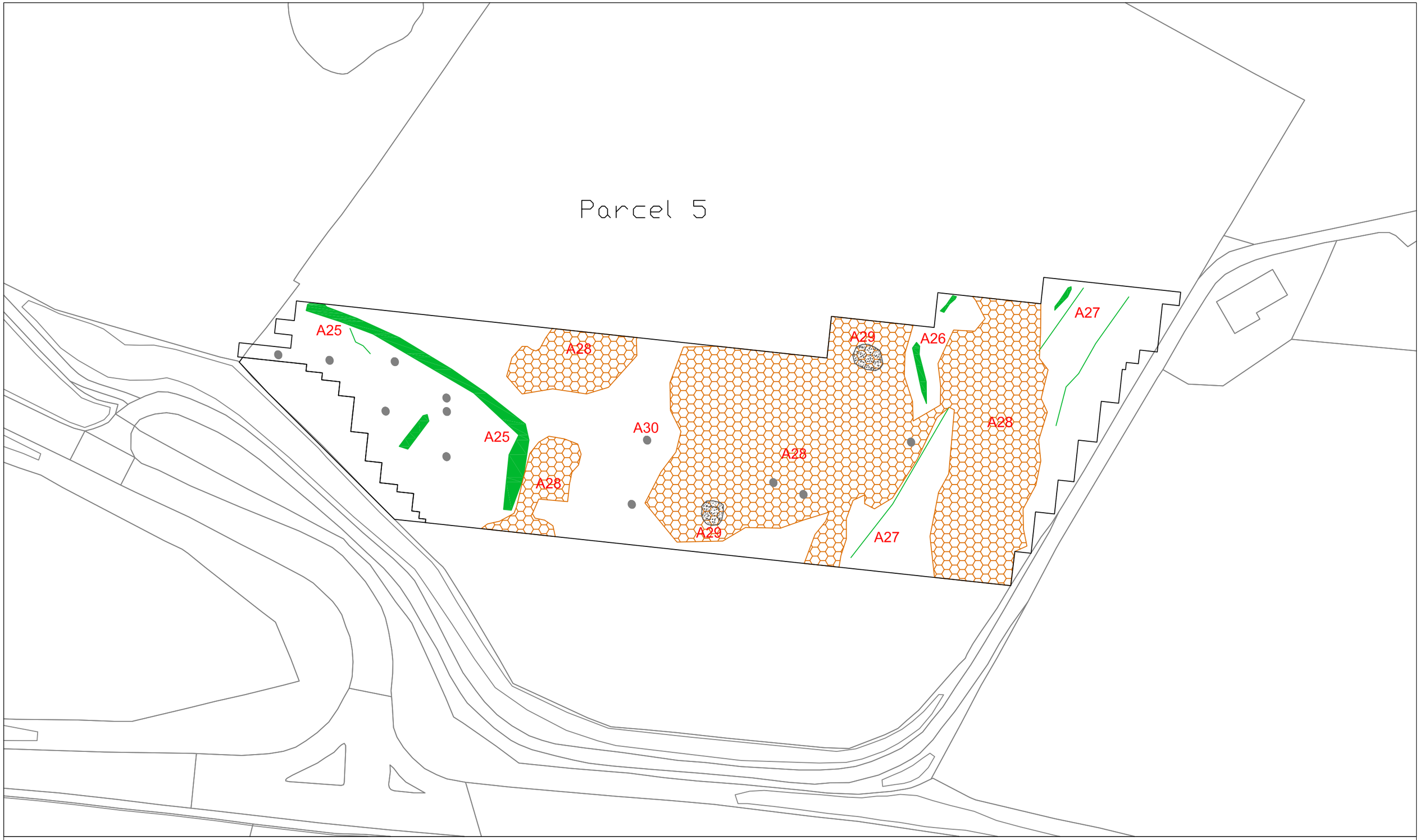
Figure 18

N

0 40m

1:1000 at A3

AOC Archaeology Group



Interpretation Plots - Parcel 5

Figure 19

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

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Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 6

Figure 20

N

0 40m

1:1000 at A3

AOC Archaeology Group

Processed Gradiometer Survey Results - Greyscale Plots - Parcel 6

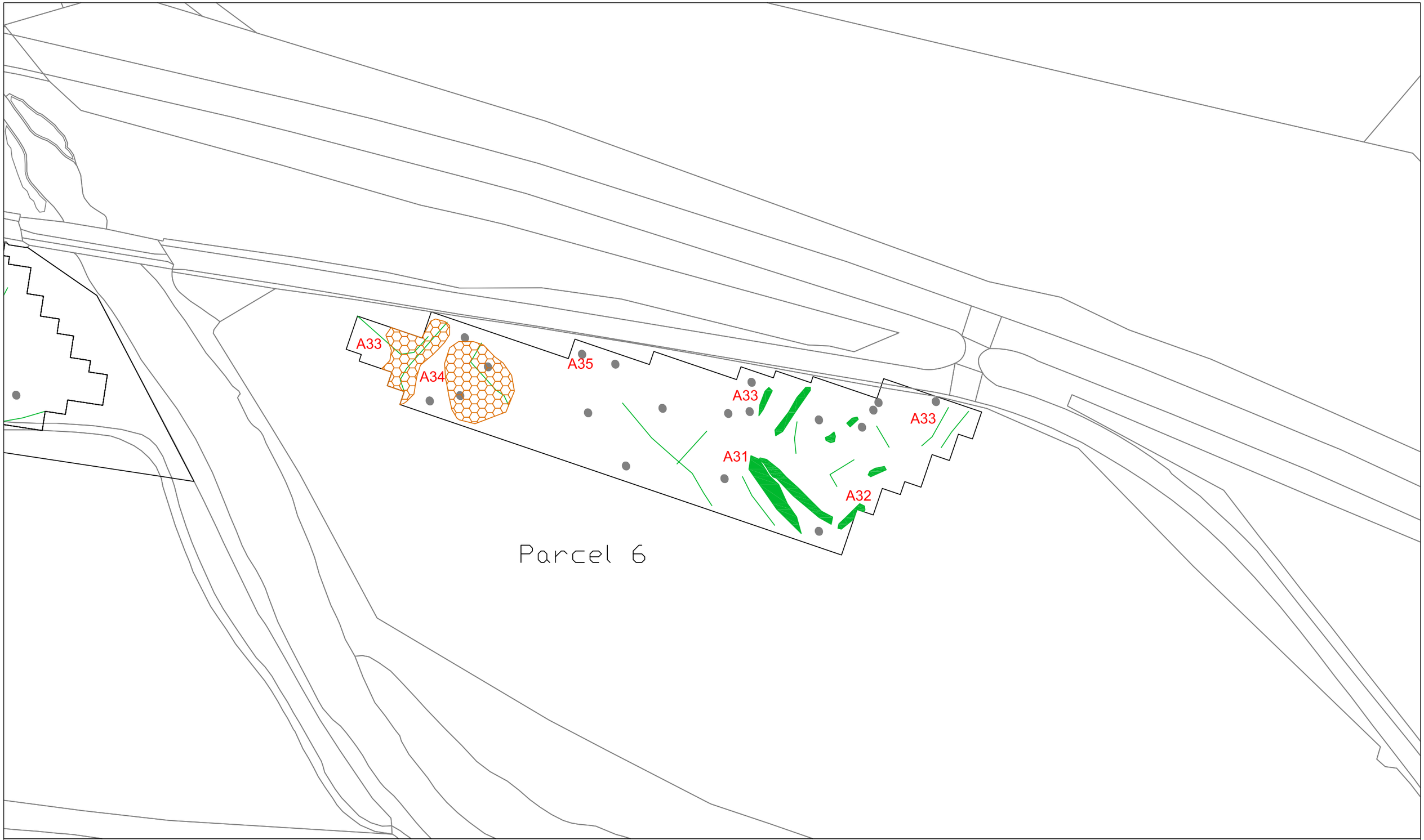
Figure 21

N

0 40m

1:1000 at A3

AOC Archaeology Group



Interpretation Plots - Parcel 6

Figure 22

N

Discrete Linear Trend (Archaeology?)
Geology / Natural
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

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Unprocessed Gradiometer Survey Results - Greyscale Plots - Parcel 7

Figure 23

N

0 40m

1:1000 at A3

AOC Archaeology Group

Processed Gradiometer Survey Results - Greyscale Plots - Parcel 7

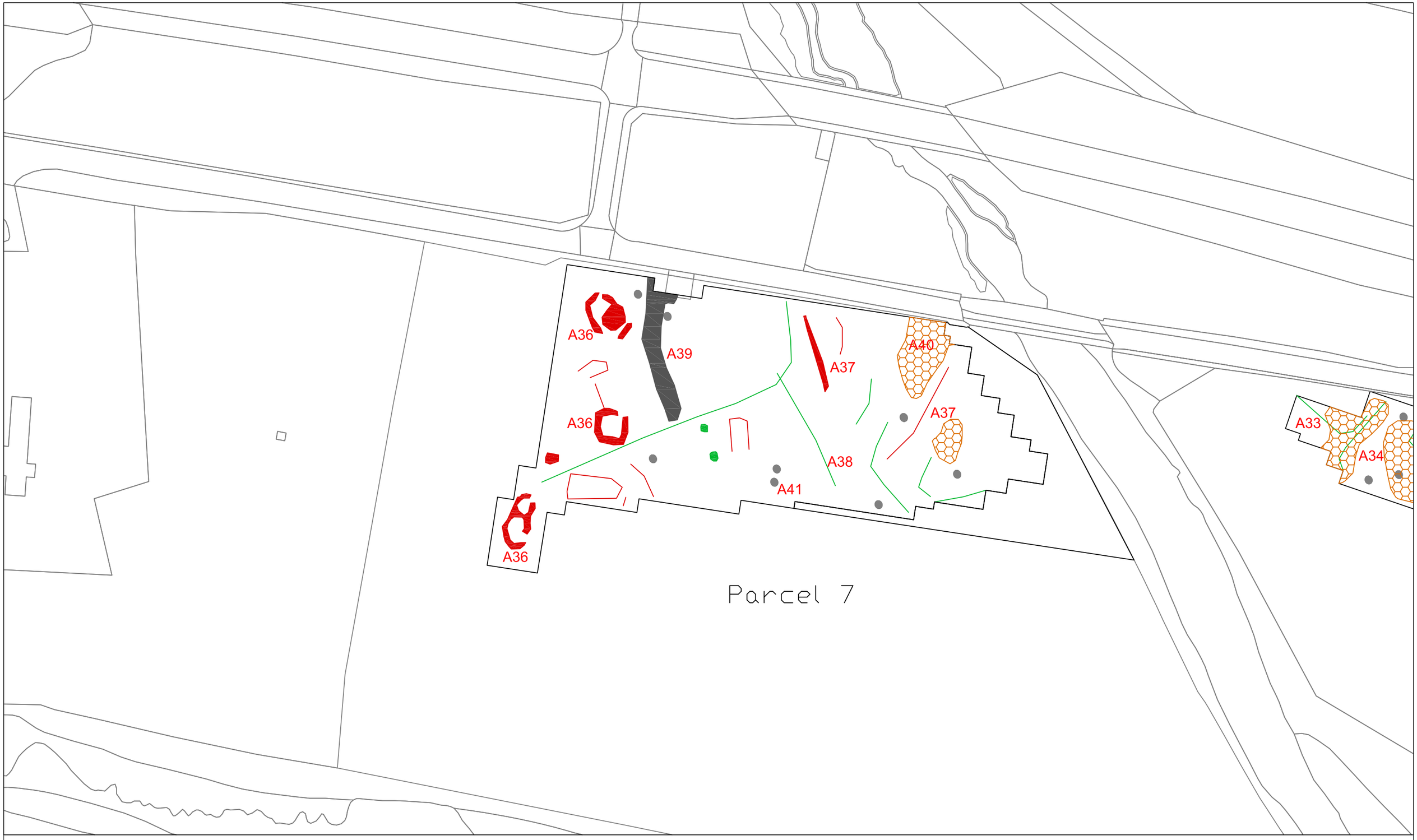
Figure 24

N

0 40m

1:1000 at A3

AOC Archaeology Group



Interpretation Plots - Parcel 7

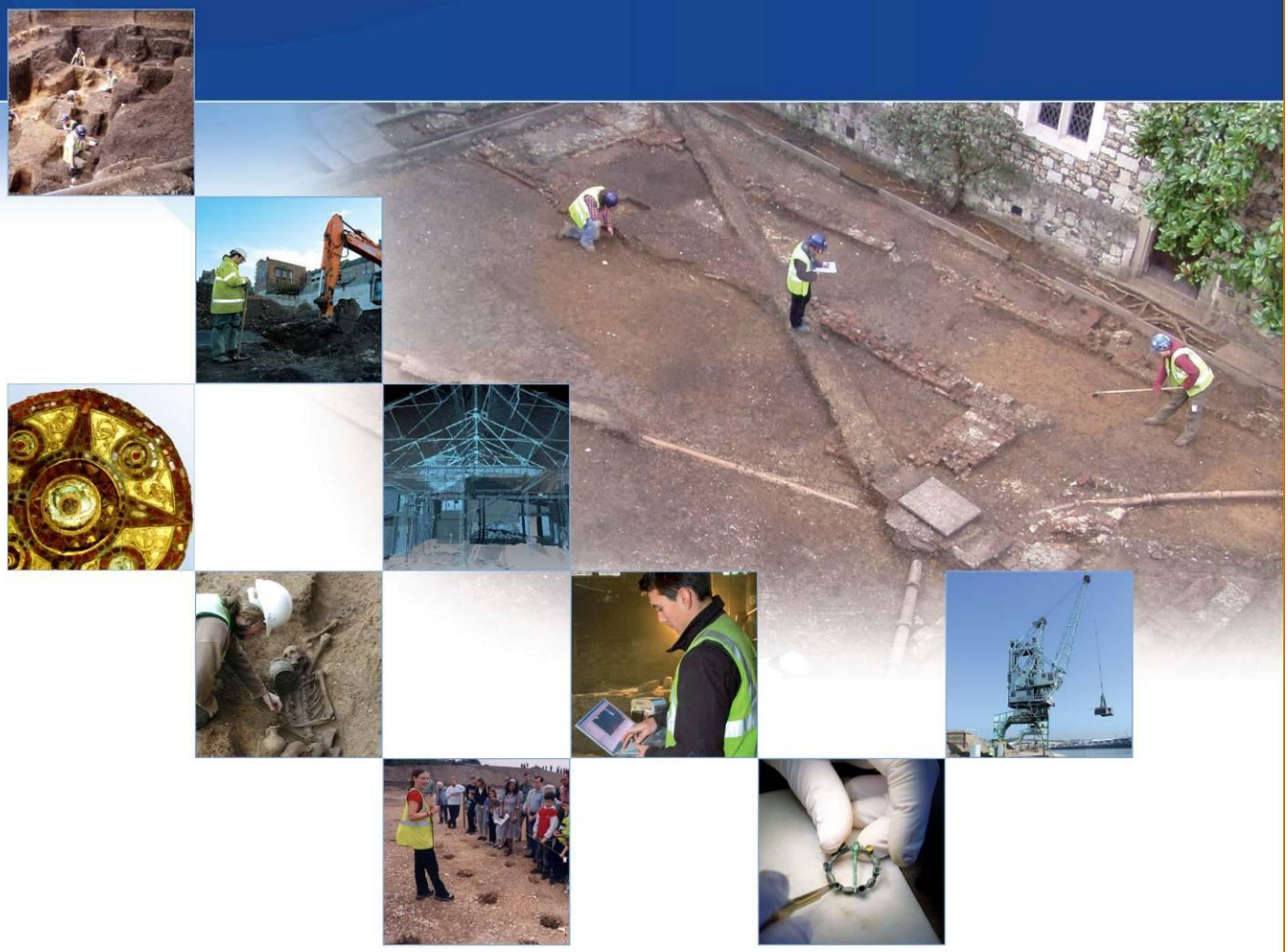
Figure 25

N

Linear Trend (Archaeology)
Discrete Linear Trend (Archaeology?)
Geology / Natural
Magnetic Disturbance (Modern)
Iron Spikes / Ferrous

0 40m
1:1000 at A3

AOC Archaeology Group



AOC Archaeology Group, The Raylor Centre, James Street, York, YO10 3DW
tel: **01904 413 404** | e-mail: **york@aocarchaeology.com**